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PRINCIPLES OF TRADE AND INDUSTRIAL TEACHING

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PREFACE

THIS book has been written to meet the needs of teachers in service, and to give prospective teachers a clearer view of what is required of the profession, a sound method of selection and organization of subject matter, and practical methods of individual instruction. In addition, it gives the fundamental psychological principles upon which the teaching methods are based.

The principal success factors in teaching which should be prerequisite to professional training are discussed, and the success factors which may be developed through training are indicated.

Definite criteria are established for the determination of subject matter in the trade and industrial arts field. Instead of a broad, general objective, which offers no adequate basis for discriminating selection of what we shall teach, there are offered very definite and exact principles for determining the value of such material.

A technic of analysis, for the purpose of selecting the learning units involved in any subject, is presented, and a number of examples of analysis are given. This presentation is simple and direct, and is not obscured by a vague philosophical theory.

The plan for the organization of the subject matter for individual instruction removes the difficulties which hitherto have been encountered. It permits individual progress without respect to the progress of the other members of the class, and fixes definite responsibilities

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upon the pupils. It shows how to select jobs and determine their value for instruction purposes. The teaching plan is one of great simplicity, and with the material properly organized it may be followed by any teacher without difficulty.

The essential principles of psychology are presented in a non-technical manner. A knowledge of these principles enables the teacher to form accurate judgments with respect to learning.

Observation and practice being essential elements in the development of a teacher, a number of observation problems are given. These may be extended if it is considered desirable to do so.

The methods presented have been thoroughly tested and extensively used in various types of schools.

The authors are indebted to the INDUSTRIAL-ARTS MAGAZINE and the INDUSTRIAL EDUCATION MAGAZINE for permission to use material which has appeared from time to time in these magazines. They also wish to express their indebtedness to Dr. T. W. H. Irion, Professor of Educational Psychology, University of Missouri, for reading a portion of the manuscript and making valuable suggestions.

R. W. SELVIDGE,
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CHAPTER I

A Statement of the Problem

1. Success Factors in Teaching. In the preparation of a book that is to be of value to teachers in service, as well as to those who are preparing to teach, it is necessary to determine the success factors in teaching, and point out ways and means of developing them. Many of these factors are common to all fields of teaching, but in this book their application to the field of trade and industrial education is emphasized.

The success factors in teaching may be divided into three main groups: what the teacher must be; what the teacher must be able to do; and, what the teacher must know.

2. What the Teacher Must Be. This includes those personal qualities and characteristics, such as physical appearance, health, habits, traits and attitudes, which, taken together, are referred to rather vaguely as "personality." Not many teacher-training institutions make any systematic attempt to develop these factors, notwithstanding the fact that more teachers fail through a weakness in this respect than from all other causes combined.

3. What the Teacher Must Be Able to Do. This involves the teaching skills, such as the choice of subject-matter and the analysis of it into suitable units of instruction, the best method of presenting the material to individuals or to groups, how to distinguish between proper methods for developing skills, acquiring information and developing thought or reasoning, how to

establish efficient and economical habits of study, how to develop a sense of responsibility and self-reliance in students, and so on through the entire range of teacher activities.

4. What the Teacher Must Know. This consists of the things the teacher must know in order to make a wise choice of means, and to perform successfully his duties as a teacher. It involves not only a knowledge of the subject-matter he wishes to teach, but a knowledge of the laws of learning and the fundamental principles of psychology. He must know these principles of psychology not as vague theories, but as the practical working principles of his profession. He must realize that every teaching situation involves certain principles which, if properly understood by the teacher, will greatly simplify the task of the instruction.

It is highly desirable that a teacher possess as many of these success factors as possible before beginning the process of specific training for teaching. One who does not know the subject-matter cannot teach it successfully, although he may know all the tricks of the teacher's trade. In general, attempts to learn the subject-matter and the methods of teaching at the same time result in a superficial knowledge of the subject-matter. This is particularly true if the subject-matter involves a high degree of skill.

Professional training is as important for the trade and industrial teacher as it is for any other teacher. The fact that one knows his trade, or is able to make things, is not sufficient. He must be able to teach something, and this something he is to teach must be very definite. It is a trite expression to say that we must

teach the boy, not the subject; but we well may ask, "Teach the boy what?" The trade and industrial teacher must know what to teach and how to teach it. He must know how to select and give to the pupils the experiences which will make them into what he wishes them to be.

5. Basic Training of the Trade and Industrial Teacher. Most trade teachers have served an apprenticeship or learning period in a trade, and have worked as journeymen for several years. Their youth was spent in learning their vocation, with little opportunity for formal educational training, and they rose to positions of leadership in their respective trades by reason of their outstanding native ability. This native ability and the thorough knowledge of their trade constitute the fundamental basis upon which they must develop their new vocation of teaching.

The industrial-arts teacher usually has had more formal educational training than the trade teacher, but he has had comparatively little training in the skills of a specific vocation. Some of them have come into the teaching profession through training and practice in the trades, but a large majority of them have received most of their shop training in schools established for the training of such teachers, and their contact with the trade has been only casual. Many of them have had professional courses for the training of teachers, but most of these courses have been based upon theories and practices developed in the teaching of academic subjects, and have been given by men who have had little or no contact with the industrial world. Psychological principles have been stated in terms of

their application to academic subjects, and the principles of teaching have been applied in a like manner.

Thus, in the training of trade and industrial teachers we have to deal with two groups of individuals having different types of preparation. This, however, presents no serious difficulty, since each is preparing to enter a different field in which his previous experience gives an adequate basis for the special training required. The prospective trade teacher is skilled in the practice of his trade, but this is only the raw material which he will use in teaching. He has had no training in the selection or the organization of the material in which he must give instruction, and he is unacquainted with the laws and conditions which govern the process of learning. His training as a teacher must correct these deficiencies.

In a like manner the industrial-arts teacher must be able to choose, classify, and arrange the experiences he wishes to give, and must be acquainted with the psychological principles and the laws of learning which affect the procedure in giving these experiences.

Notwithstanding the difference in the early experience of these two classes of teachers the problems of training have many elements in common. There are three distinct, but closely related, accomplishments which should be possessed by every shop teacher: *First,* he should be able to do well the work he expects to teach. That is, he should be a master of his subject, and not a mere amateur in it. *Second,* he should be able to take stock of his own knowledge and experience, in order to choose wisely, and organize and arrange effectively, the things he wishes to teach. *Third,* he

should be able to teach these things well. To be able to do well the work of the trade is an accomplishment which may be learned in the shop.

The analysis of the trade into its teaching or learning units is a professional problem of the teacher which must be solved before instruction begins. The ability to teach effectively requires an understanding of the principles of teaching which are based upon well known psychological laws.

6. Effective Teaching. Subject mastery and the analysis of the subject-matter into satisfactory units of instruction are necessary elements in effective teaching; but a knowledge of the elements involved in a learning situation, and the ability to set up conditions in such a way that the desired learning will take place, are equally important. The fact that an individual knows how to do a thing is no guarantee that he will be successful in getting others to learn from him. If he is to do effective teaching he must not only know the essential laws of learning and the principles of teaching, but he must follow them. He must know some of the more important facts concerning learning principles and the factors which affect them. The teacher need not be a psychologist, but he should be familiar with the indisputable facts established by the experimental psychologists, and be able to use these facts in organizing his subject matter, and in giving instruction. A lack of knowledge or understanding of these practical facts will lead to serious blunders and poor teaching.

7. A Knowledge of How We Learn Is Necessary. The *stimulus-response theory,* which is recognized as

one of the guiding principles upon which much of modern teaching method is formed, must be recognized as a factor affecting shop instruction. It is basic to a clear interpretation of the laws of learning, the emotions, feelings and attitudes, individual differences, the problem of intelligence, reasoning, interest, transfer, the presentation of subject-matter, and the comprehension of written forms of instruction.

The need of knowledge concerning how we learn is apparent every day in situations which confront those who share in the responsibility for giving instruction. It is not uncommon for the teacher to be so familiar with the subject-matter that he overlooks the fact that the learner probably is not informed about the most elementary phases of the subject. Pupils often go away confused because the teacher has slighted parts of the lesson which he thought too elementary to require attention. He has told certain things, but has not taught in a systematic way. He has talked and shown too much, and has failed to give the pupils an opportunity to think or properly to participate in the lesson. Such failures are not uncommon.

To illustrate: A draftsman of long experience was employed to teach mechanical drawing in an evening school. He possessed two of the important qualifications of a teacher—he knew his subject, and it had been analyzed. But he lacked training as a teacher. Those who employed him were of the opinion that he was well qualified to teach. Without training under supervision as a teacher, the analysis of his subject-matter meant little to him. He spent the first evening telling about his experiences in order to "establish himself."

He was three evenings in getting this and certain other details done without teaching any of the elementary things a draftsman must know and be able to do. He failed to start where the pupil must start, and did not build up an interest in the work through participation. Recognizing an apparent uneasiness among members of the class, he plunged into the work of drafting, only to find, after an evening or two, that some difficulties might be cleared up by teaching how to use the common instruments which seemed to him at first to be quite elementary and unnecessary. Interest was already lagging, and students had dropped out. He was learning to teach, but too late to be of value to that class. It was costly to his employers, and disappointing to the learners.

There are many situations analagous to this, even among trained teachers, because they have seen no relation between the psychological principles of learning and their problems of teaching. In order that students in teacher training may have opportunity really to evaluate these principles in terms of shop teaching, provision should be made for observing them in practice and using them in shop classes.

8. Observation and Participation Necessary in Training Teachers. Observation must be carefully planned if it is to be of any real value. It must be directed to specific things, and the observer must be familiar with the principles involved in this particular phase of activity. With a definite assignment, carefully detailed methods of procedure, and a well organized question outline covering the points to be observed, the observation may be made highly effective with a minimum

expenditure of time, and little interference with the regular routine of work.

The ability to do good teaching is based upon certain inherited characteristics plus training and experience. Excellent native endowment, knowledge of the subject-matter, and familiarity with the laws of learning and methods of teaching are not sufficient. Observation of, and participation in, teaching is necessary. One must experience the feel of the real teaching situation. In no other way can one get an adequate training in teaching. There must be opportunity to observe the application of the principles of teaching by others, followed by opportunity for the application of the principle in a practical situation by the teacher in training.

9. Measuring Results. In order to know whether our teaching is effective or not it is necessary to measure the results. The best means of determining this is through tests. Tests are not entirely satisfactory because of the great number of chance conditions entering into their administration. Many who were classed as failures in school have succeeded in vocational life, and many have failed in their vocations who were classed as successes in school. However, we cannot govern our present activities by the possibility of future events, so we must rely upon tests to determine whether we are attaining the ends sought. It is important that teachers be familiar with measuring devices and know how and when to use them.

10. Summary. Our problem is to determine, as accurately as possible, the principal success factors involved in teaching, and to give such assistance as we may in developing or acquiring them.

Success factors fall into three main groups:

1. *What the teacher must be.* This includes those personal qualities and characteristics, such as personal appearance, health, habits, and attitudes, which, taken together, are referred to rather vaguely as personality. Many of these are inherited characteristics, but all may be improved through careful training. It is important, however, that the prospective teacher have these characteristics well developed before beginning his professional training.

2. *What the teacher must be able to do.* This involves the teaching skills, such as the choice of subject-matter and the analysis of it into suitable units of instruction, the best methods of presenting material to individuals or to groups, the ability to choose the proper methods for developing skill, acquiring information, and developing thought or reasoning. He must be able to create situations which will develop a sense of responsibility and self-reliance in the students. These activities often are classed under the heads of "Selection and Organization of Subject-Matter," "Methods," and "Management."

3. *What the teacher must know.* This consists of the things the teacher must know in order to make a wise choice of the means of instruction and to perform successfully his duty as a teacher. It involves a knowledge of the subject matter he wishes to teach, the laws of learning, and the fundamental principles of psychology. These he must know as practical working principles of his profession. He must know, also, how to test the effectiveness of his teaching and the progress of his pupils.

CHAPTER II

What the Teacher Should Be

11. Relative Importance of Knowledge of Subject. The idea prevails in many quarters that a knowledge of subject-matter is the principal factor of success in teaching. This notion has persisted so long and has been so generally accepted that it has greatly affected the type of people who enter the teaching profession, and has, to a large degree, influenced their training. Even among those who have recognized that a thorough knowledge of subject-matter is not sufficient to insure success there has been the tendency to confine the training to a knowledge of psychology and the mechanics of teaching. In most cases academic knowledge of the subject-matter has been the only prerequisite to professional training.

The prevalence of this idea has been most unfortunate for the teaching profession, and for society as a whole. It has made the profession a sort of catch-basin into which those fell who had only a knowledge of the subject-matter, and did not possess the success factors which are necessary in other lines of work. It was assumed that the individual could teach because he knew his subject, and if any doubt existed concerning his success, he could remove it by taking a few courses in psychology and methods of teaching. It is unfortunate that our attention has been concentrated on these two success factors to the almost total exclusion of others.

We cannot go far in successful teacher training until

we know quite definitely what constitutes the success factors in teaching. Undoubtedly a knowledge of the subject-matter is one of these factors; the ability to analyze it and select suitable teaching units is another; and a knowledge of the laws of learning is still another; but these are only the more generally recognized factors. We may have beautiful lighting fixtures in our home, but the lighting is unsatisfactory if there is a fluctuation in the voltage. So we may train and polish the individual in subject-matter and methods, but if he does not possess the necessary personal characteristics he will be unsatisfactory as a teacher. We are not to conclude from this that "the teacher is born, not made," but we may rightly conclude that he is born with or without certain potentialities that are essential to success as a teacher, and if he is not born with them, professional training will not make him a successful teacher.[1]

12. Success Measured in Terms of Development of Students. The results obtained, measured in terms of the development of students, represent the true success of the teacher. We cannot measure that result, however, until the teacher has taught; but the teacher trainers and the prospective teachers need to know in general what qualities and accomplishments on the part of the teacher contribute to the desirable development of the pupil. No very exhaustive study has been made to discover these factors, and to place upon them relative values, and yet this is perhaps the most fundamental thing in the selection and training of teachers. The nearest approach to it is the list of points in the

[1]See Chapter X, p. 210.

rating scale employed in some of our school systems, and if these scales are correct they give us a list of the essential points in which teachers should be trained.

For some unaccountable reason, teacher trainers appear to feel that their mission is fulfilled when they have presented text material and have given lectures on a particular phase of teaching. They do not realize that they are training individuals, and that such training, in order to be effective, must be intensely personal. The teacher trainer who is willing to dispense with a large per cent of his lectures, and to give his time to personal conferences, will find himself abundantly rewarded by the improvement in the results obtained.

13. Vocation of Teaching Must Be Analyzed. In order to determine what course the training should take, it is necessary that the vocation of teaching be very carefully analyzed for the elements which contribute to success. This is not a "job analysis," a term much used in a very careless and inaccurate manner in connection with vocations, but a genuine vocational analysis. This cannot be determined by an examination of the courses given in teacher training institutions, but must be determined by the qualities and characteristics possessed by successful teachers.

14. Success Factors in Teaching Must Be Listed. An examination of such a list of success factors will reveal that most of the factors are common to all fields of teaching. The amount of professional training necessary in the special field is relatively small. Before any teacher is permitted to enter on a teacher training program he should have such a list placed in his hands, and he should be made to understand that these things con-

stitute the definite objectives in the training course. Through self-appraisement he should determine, as accurately as possible, to what degree he meets these requirements and in what phases he is deficient. The training agency, through tests, examinations, and personal appraisement, should determine whether the candidate for training possesses the required potentialities and accomplishments to give reasonable hope for successful training at a cost that will not be too great. The rating on each of these elements should be recorded, and the type and character of training required for each individual should be recommended.

These findings should be presented to the candidate and explained to him. This gives him a definite personal program. He may doubt the accuracy of the diagnosis, and in some cases his doubts may be well founded; but he should understand that such conclusions have been arrived at as a result of careful examination, and that probably the estimate coincides with the estimate in which he is held by his acquaintances. With such a starting-point the trainer and the prospective teacher are working toward a common end.

It is necessary for the prospective teacher to know his deficiencies in order that he may correct them; and he must know them as his own individual deficiencies, and not regard them as common to all persons in training, or possibly that they are the characteristics of some other member of the group rather than his own. Improvement is an individual process and an individual responsibility. The teacher trainer can only point out the factors in which training is required, and assist the individual in his effort to improve in these

particulars. There should be complete confidence and the closest cooperation between the teacher trainer and the prospective teacher. Anything short of this will greatly interfere with the success of the training.

15. Five Major Success Factors Prerequisite to Admission to Training. There is enormous waste as well as grave injustice in admitting to teacher training those who rate low in their chances for success. There are five major factors which should represent the minimum requirements for entrance, some of which represent native endowment or fixed habits which it is impossible, or very difficult, to change or improve. Others may be improved, but there should be a strong foundation on which to build. These requirements are:

1. *Good moral character.* This is so much a matter of fixed habit difficult to change, and it is so important as a factor in developing the character and ideals of the young people with whom the teacher is associated, that we cannot afford to assume the responsibility of correcting any serious defects in the moral character of those who desire to be teachers.

2. *A good health rating based upon a thorough physical examination.* Few teachers or teacher trainers realize the importance of this success factor. Indeed, it is neglected and sacrificed by many in order to gain a slight additional proficiency in theories of teaching, or a more extended knowledge of so-called subject-matter. This factor should never be neglected for the sake of the others. There should be a good foundation in health for entrance, and systematic instruction and training should be given in order to maintain and improve it.

3. *The individual should be normal or above in intelligence.* This important success factor cannot be increased by training. It is, therefore, important that we exclude from training those who rank low in this respect. Intelligence testing has been developed by men in the teaching profession, and, while it is not an infallible guide, we may well use it as one of the means of selecting candidates for training.[2]

4. *The individual should possess sufficient general education to enable him to pursue with success the professional study which he wishes to undertake.* This is essential to his success, but cannot be regarded as a part of his professional training. For example: He should be well trained in English, spoken as well as written. This should include spelling, writing, pronunciation, vocabulary, grammar, ease of expression, conversation, forms in letter writing, form in the arrangement of material, and the ability to read with ease and accuracy. In his special subject he should have at his command the information to be taught, and the skill to be developed.[3]

5. *He should possess an adequate knowledge of the subject or material he wishes to teach.* The professional part of teacher training ordinarily is, or should be, based upon the assumption that the individual has an adequate knowledge of the things he expects to teach. In the academic field this usually is acquired in school prior to or parallel with the professional courses. In the industrial field it must be acquired very largely in the industry prior to the training

[2]See Chapter XIV, p. 287.
[3]See Chapter XVII, p. 332.

course. However, in many cases the training in the industrial field is so haphazard, unorganized, and deficient in certain important respects that it is necessary to organize and supplement the experience in the school.

16. Other Success Factors. There are certain other habits, traits, and attitudes, important as factors of success, which may be successfully developed if the candidate does not already possess them. In these things careful, systematic, individual instruction should be given, in order to meet the needs of each member of the group. Good inheritance, proper early environment, and training have much to do with these factors. If they are not present to a fair degree, training will be difficult, even with the most careful individual instruction. Perhaps the most efficient method of procedure is to make the individual conscious of his specific deficiencies and encourage him to strive to correct them. Frequent checking of progress is an important factor in this development.

Unusual superiority in one or more of these factors may compensate to some degree for deficiencies in others, but a marked shortage in any one of them is a serious handicap which should be corrected if possible. These success factors will vary in importance with different teaching situations. The more important of these personal attitudes and habits which affect success in teaching may be stated as follows:

1. *General Appearance,* including carriage, attitude, dress, and personal neatness. Many teachers fail of advancement because of lack of these characteristics.

2. *Voice,* including pitch, quality, ease, clearness, and pleasant habits of speech. A harsh, gruff, or high pitched voice, or unpleasant habits of speech, are serious handicaps which may be corrected by practice if one is conscious of the defect.

3. *Health habits,* including exercise and proper care of the body to give the greatest possible promise of health. Careful training in this respect is important, and will give most gratifying results.

4. *Initiative and independence* in originating and carrying out ideas. Native ability and early experience may be important factors in this element, but it can be improved by providing a proper situation for its development. Carefully selected problems constitute the best means of doing this.

5. *Industry and alertness,* both mental and physical, are important factors. Habits of industry and alertness may be developed as surely as habits of indolence and indifference. Like all habits they are developed through repetition, and we may not expect habits of industry if we permit the practice of indolence.

6. *Tact,* including adroitness, and a quick appreciation of the proper thing to do and say. This is a characteristic difficult to develop, but a habit of thoughtful consideration for the feelings and opinions of others will do much in this direction.

7. *Poise,* including the ability to control and conceal one's emotions, and to proceed with an apparent feeling of power and mastery in any situation. This attitude may be, in a large measure, the result of inherited temperamental characteristics and early environment, but a recognition of its importance as a success factor,

and a systematic effort to control one's emotions, will greatly improve one in this respect.[4]

8. *Honesty,* including accuracy of statement, sound moral principles, moral courage, and fair mindedness. The recognition of the importance of these as ultimate factors of success, rather than temporary advantage, together with the checking of any deviation from them, is perhaps the most effective method of developing these characteristics.

9. *Loyalty,* including cooperation, and an attitude of helpfulness, a feeling of responsibility, and a hearty support of superior officers. Practice in team work and in carrying out projects in which the participants must submerge individual interests constitute excellent means of training.

10. *Professional interest.* This includes a professional spirit, recognition of the dignity and service of the work, high standards of professional ethics, interest in the profession as a profession and not as a temporary employment. It is unfortunate that many men who came from the practice of a trade into trade teaching look upon the teaching as simply another job and not as a profession. There must be an interest in the homes and activities of the community, including leadership or participation in these activities, as well as an interest in the lives and activities of the young people inside and outside of school.

17. Professional Training. While professional training should be restricted to those who possess, to a reasonable degree, the characteristics and accomplishments suggested as prerequisite, it does not follow that

[4]See Chapter XII, p. 256.

the professional training should neglect the further development of these factors. Indeed, such a development should be a definite part of every professional training program.

The first step in such a program is the recognition that individual instruction and assistance are necessary; the second is the recognition of the importance of these success factors; the third is the general appraisement of the individual with respect to them; the fourth is the development of situations in which they may be practiced; the fifth is a habit of self-checking.

In a small training group, or in a group sufficiently well acquainted to form fairly accurate judgments, a list of success factors may be prepared and the names of the members of the group arranged so as to permit a rating of each member on all factors. This rating-chart may then be given to each member of the group who will rate all members, including himself. These ratings may then be summarized for each student, and given to him as a guide in directing his efforts toward improvement.

In addition to his training in these factors, the prospective teacher should have adequate training in the principles and skills of teaching. This covers a very broad field, including the fundamental principles of psychology as related to learning, the analysis of subject-matter, the selection of appropriate units of instruction, effective methods of presentation, the selection and arrangement of materials and equipment used in instruction, checking results, and the general psychological conditions favorable to learning.

18. Summary. Personal traits and characteristics are important success factors in teaching. Some of them represent native endowment and some are acquired. Habits of long standing are difficult to displace, and we should be cautious in accepting for training one who possesses undesirable habits. The development of desirable habits and traits is just as much a part of the professional training of the individual as training in methods of teaching and classroom management.

QUESTIONS—CHAPTER II

1. Are there success factors required in trade and industrial teaching that are not required in other fields? If so, what are they?
2. Consider your two favorite teachers: What were the characteristics or accomplishments of these teachers that made them your favorite teachers?
3. Consider two of your least satisfactory teachers: What factors led you to place them in this class?
4. Make a list of success factors and rate at least four teachers or four members of your training group on each factor. Use a scale of 10.
5. Assume an attitude as impersonal as possible, and rate yourself on each point, as compared with the four individuals selected.

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CHAPTER III

What Shall We Teach?

19. The Desire to Learn. Teaching is the response to a desire to learn, and while one may have a desire to learn without being taught, we cannot teach one who does not desire to learn. The teacher's difficulty does not lie in teaching a person what he is already interested in and desires to learn, but in interesting him in the things he should be taught. The first task for the teacher, therefore, is to select the specific things he wishes to teach, and then create a situation in which the pupil will desire to learn them.[1]

20. Must Provide Desirable Experience. Learning a few things does not constitute an educational program, nor does the knowledge of them mean that one is educated; but we must not overlook the fact that education and proper training are ideals built upon certain desirable experiences. It is, therefore, the duty of the teacher to select out of our complex life and experiences the specific things which will give the basis for the education and training desired. The selection of this material cannot be left to the temporary interests of inexperienced youth. The teacher must look at the ideal—the structure he wishes to build—and select and arrange the experiences so as to give that result.

It is a case of analysis and synthesis. The teacher's position is like that of the builder who has the plans for a great structure. He sees it as a completed edi-

[1]See Chapter XVI, p. 319.

fice, but he knows that it is made up of an almost infinite number of small units, each of which must be accurate and exact in detail in order that the structure may be complete with all the beauty and perfection in which it was conceived. He must analyze the general plan and provide for every detail. In like manner, the teacher must be able to visualize every detail of his general plan, and must select and provide for the experiences which will give the ideal he wishes to realize.

This applies to general education as well as to special forms of training. It is necessary for us, first, to know, as exactly as possible, the ideal we wish to attain, just as the builder must know the plans and specifications for his job. With the ideal or general objective clearly before us, we must examine it with the greatest care in order to discover the details which compose the larger structure. The teacher must select the experiences that will give the required result, and every experience proposed must be examined in the light of whether it will contribute to the desired end.[2]

Just as the builder rejects the material, or the workmanship, which will not make of his structure the thing he wishes it to be, so the teacher must exercise the same conscious care in the selection of experiences from which he is to build his structure.

21. The Purpose of Education. The general purpose of education and training is to aid the individual in living a useful, happy, and successful life to as high a degree as is possible in view of his abilities. In order to do this, it is necessary that he should know the social conventions of language, manners, and the customs of

[2]See Chapter XI, p. 238.

the group in which he moves. It is also necessary for him to have the information and a knowledge of the facts that are known to the majority of his group. In addition to this, he must have certain attitudes and ideals which make for social betterment. He must be self-reliant, capable, and self-respecting. In his vocation he must be competent.[3]

22. The Purpose of Trade and Industrial Training. In the teaching of trade and industrial subjects we are interested chiefly in those experiences which build up the doing side of our ideal—the things which tend to make one competent in his vocation, or which enable one to meet with confidence the situations in his daily life in which some mechanical ability, elementary skills, or knowledge of industrial practices are required. We are, therefore, confronted with the question of what the individual must know and be able to do with respect to industrial practices and processes, in order that he may attain the ideal we have set up for him.

23. The Field of Industrial Arts. The question is more difficult to answer in the field of industrial arts than it is in the field of trade education, for the reason that in the field of trade education the scope is relatively limited, while in the field of industrial arts a very wide range of experiences may contribute with equal effectiveness to the desired end. In this field we seek to give the youth the information and experiences which will interest him in industrial life and enable him to do effectively the things that most boys and men are called upon to do without respect to their vocation. It is by no means necessary to give the pupil training in

[3]See Chapter XVII, p. 332.

making the identical things he later may be called upon to make, but it is important that we give him experiences capable of wide application, and develop in him a habit of orderly procedure and systematic work which will be of value to him in any line of endeavor.

24. What the Industrial-Arts Program Should Include. There are certain fundamental skills, attitudes, and habits that are common to many types of work that may be developed through one type of work almost as well as through another. The emphasis, therefore, should be placed upon the things we wish to teach rather than upon the things we wish to make. Neither broad, general objectives nor a list of projects constitute a satisfactory program. Our program should be expressed in terms of the information, the attitudes, the interests, the skills, and the habits of work we expect the boy to have when he has completed his period of training. These may be expressed as follows:

1. A well developed interest in industrial affairs.
2. How to care for and use properly the things we buy.
3. Appreciation of good workmanship and good design.
4. Attitude of pride and interest in one's ability to do things.
5. A feeling of self-reliance or confidence in one's ability to take care of oneself in an unusual situation.
6. A habit of orderly and methodical procedure in the performance of any task.
7. Knowledge and understanding of the conventions of mechanical drawing, and ability to express one's ideas accurately by means of a drawing.
8. Elementary skills in the use of the more common tools and machines, and in the methods of modifying and handling materials, in order to make them conform to our needs.

25. A Well Developed Interest in Industrial Affairs. Most of our school work is directed toward the development of interests in so-called academic things, with lit-

tle effort toward the development of interests in the work of the outside world in which the boy must soon participate.

Interest in industrial affairs is one of the most important factors in guidance. It may be developed through a study of some of the principal phases of manufacturing and distribution, and a knowledge of the sources, qualities, and characteristics of the industrial materials in common use, such as wood, iron, steel, copper, brass, aluminum, cement, rubber, glass, paper, fabrics, and manufactured articles generally. No difficulty will be experienced in developing an interest in industry if the material is carefully selected and well organized. There is an interesting story connected with every product. Some of the items to be considered are:

1. The sources of the raw material and the methods of preparing it for use.
2. The durability and adaptability of the material for particular uses.
3. The working qualities and characteristics of the materials.
4. How certain things are made.
5. The commercial sizes, grades, classifications, and sales units.
6. The organization and operation of the industry.

These things must be handled with the definite purpose of developing an interest in industrial life and processes, rather than from the standpoint of giving highly accurate technical information concerning them.

In such a study of industries we are not limited to those activities involving materials which may be fab-

ricated in the school shop. The bakery or the laundry represent industries just as much as the machine-shop or furniture factory.

A wide range of material may be presented by assigning different topics to different individuals and requiring reports to the class. It often is well to have two individuals work together on the same problems.

The following Assignment-Sheets illustrate one very excellent method of handling this material.

ASSIGNMENT SHEET

Problems in Public Service

Assignment: Make a written report on how we get our water supply.

Directions: Make a list of the principal points upon which you wish information, and visit or telephone the Water Commissioner's office to arrange for an interview. Your interview should be brief and businesslike. When completed, secure permission to visit the pumping plant and reservoirs, thank the official for his courtesy, and retire promptly.

As a result of your interview and your visit to the plant, you should be able to answer the following questions:

1. What is the source of supply—wells? river? lake?
2. Is the supply constant and adequate at all times?
3. What precautions are taken to make sure of constant supply?
4. What are the possible sources of contamination?
5. What precautions are taken to prevent contamination?
6. Is the water pumped into a reservoir and then into the mains?
7. Does the water receive any kind of treatment before it is pumped into the reservoir or mains?
8. If it does, what is the purpose of the treatment?
9. Is the pressure in the mains maintained by pumps, or by gravity?
10. What is the average amount of water used per day per individual?
11. What is the cost per gallon?

ASSIGNMENT SHEET

The Manufacture of Flour

Assignment: Make a written report on how flour is made.

Directions: Visit the local flour mill and ask to see the manager. You probably will be asked by the person to whom the request is made to state your business. If so, tell him your name, your business, and why you wish the information. This should be thought out very carefully before you go to the mill. When you meet the manager, introduce yourself and state your business. If he does not have time to give you the information desired, ask him to designate some one who can. Be courteous, brief, and businesslike. When the interview is finished, thank him and ask if you may be shown through the mill.

As a result of your interview and observations, you should be able to answer the following questions in your report:

1. What is the capacity of mill in barrels per day?
2. How many employees? (From the answers to these two questions, you can get the number of barrels of flour produced per man per day.)
3. Where is the wheat grown? Is it hard wheat or soft wheat?
4. How is it brought to the mill?
5. How is it unloaded?
6. How is it handled in the mill?
7. What processes does the wheat go through in making it into flour?
8. What other products besides flour are obtained in milling wheat? What are they used for?
9. In what part of the country is the flour sold?
10. Is the flour packed in barrels?
11. What constitutes a barrel of flour?
12. Do you think it would be a pleasant place to work? Why?

These assignment-sheets constitute outlines for reports as well as suggestions which act as a guide for the young investigator, and should cover the main points on which a report is required. The problems assigned should be of general interest, and the reports should be presented to the class, and opportunity given for questions and discussion.

Such reports offer an excellent opportunity for cooperation with the English department. Most English teachers desire to cooperate, but they do not know enough about industry to enable them to suggest satisfactory topics, or to assist the pupil in outlining his investigation and report.

Vocational guidance at this stage in the boy's life is largely a matter of developing an interest in useful and desirable occupations, rather than the selection of a particular vocation, and this type of study offers the best means of developing a vocational interest. The most important thing in guidance is to develop in the youth a strong desire to be something that is worthwhile and that is sufficiently remote to be impossible of immediate realization. What he wishes to be is relatively unimportant so long as it is honorable and he is willing to make present sacrifices in order that he may realize it some time in the future.

26. How to Care For and Use Properly the Things We Buy. This involves a knowledge of some of the elementary principles of science, such as the effect of heat on metals, effect of moisture on wood, rust, methods of preserving materials, how the electric current works, how to trace the lines of power through a mechanism, the principles of machines, lubrication.

These things do not involve skills but certain fundamental knowledge and understanding of natural laws. Enormous losses occur every year because people do not know the importance of protecting materials from the action of moisture. They have only a vague understanding of why doors, and drawers in furniture give trouble in damp weather, or why furniture cracks

and falls to pieces during the heating season. Machines are worn out with a mere fraction of the service they should render, because they are not properly lubricated or cared for.

There should be an understanding of the conditions under which the electric current works, as that is the chief source of power in the home. This does not necessarily involve skill in the manipulation of electrical materials, nor the making or repairing of electrical equipment, but such work, if wisely chosen, will greatly aid in the understanding of how this power operates.

One of the most important things we can teach the young people in industrial-arts courses is that they should not abuse the things they buy or use. They should be taught how to care for and preserve materials; how to care for equipment and furnishings in the school and home; and how carefully and thoughtfully to correct, without damage to the article, any difficulty that may appear.

They should be taught that manufactured articles are made with a view to their use under certain conditions, and for certain purposes, and that they probably will give satisfaction when used under those conditions, and unless one is prepared to use them under such conditions he should not buy them. For example, a rayon garment may be very durable if it is laundered as prescribed by the maker, but if it is not, it fails immediately. The person who adjusts a nickled fitting, or a finished nut with pipe-pliers, or who violently strikes a watch on his hand to make it start, or who uses force to make a mechanism work without first locating the trouble and knowing what force is required,

and how it should be applied, is close akin to the vandal who maliciously destroys property.

With the advent of machinery into the household, and into the hands of the inexperienced operator, there should come an understanding of the principles of machines and mechanisms. It should be understood that machines are manufactured to operate properly, and that they usually will do so if properly cared for as directed by the manufacturer, and used for the purpose intended. People who are to use machines should be taught that when a machine fails to operate it should not be forced, but that the faulty adjustment or difficulty should be located and corrected. This is best taught by showing how every mechanism, from the simplest to the most complex, is actuated by power applied from the outside.

This mysterious thing called power is carried through the machine along definite lines from the point where it enters the machine to the point of doing the work. Every movement in the mechanism is based upon some well established mechanical principle, and the machine will perform as it was designed to perform if these principles are observed. The trouble comes when some principles are violated. The movement of power through the machine may be seen in a simple form in the mechanism of an ordinary door-lock. In this case the hand furnishes the power which is conveyed through the key to lift certain parts and throw the bolt into position. It is seen in a more complicated form in the sewing-machine, where the power comes from the operator's foot or from a small motor, and the power is divided into several lines on entering

the machine. One line moves the shuttle, one the feed, and one the needle. All of these movements must coordinate and come together at the point of doing the work.

Such a study and understanding of machines is both valuable and fascinating.

27. Appreciation of Good Workmanship and Good Design. This will mean the study and comparison of materials, workmanship, structure, design, finish, and the other elements involved in a satisfactory product. These judgments are most valuable when based upon experience in dealing with the materials in similar situations. They involve such things as the application of the simple rules of proportion, color harmony, balance, and appropriateness in use.

Mere talking about such things will not suffice. There should be a critical comparison of design in furniture, furnishings, houses, and the various elements involved in their construction, their setting, and the factors which tend to make them pleasing and attractive. There should be an attempt to develop the ability to distinguish between the fad, or bizarre effects, which often prevail for a time, and the quiet, substantial, and satisfying design based upon the fundamental principles of simplicity, usefulness, good proportion, pleasing lines, variety, and harmony.

28. Attitude of Pride or Interest in One's Ability to Do Things. The habit of close observation of how things are done, and of trying to determine why they are done in that particular way rather than some other, is well worth developing. A thoughtful and observant attitude towards even the most menial tasks

should be developed. Every undertaking involving the expenditure of human energy is worthy of study with a view of making that expenditure more effective. It is true also that many of the tasks with which we are confronted are difficult because we do not know how to go about doing them rather than because of the skill involved. The information gained from observation often is quite valuable in an emergency.

Pride in one's ability to do things is one of the best guarantees of good citizenship. It can be acquired only through successful accomplishments, and every pupil should be trained until he can do well at least a few things. This avenue to self-respect should not be neglected. We like to do the things we do well, and a distasteful task in learning may become a pleasure in accomplishment.

In order to develop this attitude we must require good workmanship. No one with right ideals with respect to standards can take pride in careless, slovenly work. It is a great mistake to suppose that, in order to maintain interest, we must permit and approve poor work and low standards of accomplishment. Nothing is more detrimental to permanent interest. If we are careful to assign tasks within the capacity of the pupil, high standards of accomplishment may be secured by the judicious use of comparison, criticism, and praise. Boys take pride in doing difficult things if their efforts receive proper recognition, but to give praise or approval of a piece of work beyond what is rightly deserved is to lower the ideals of the pupil and decrease his respect for himself and his work. Interest in attaining high standards of workmanship may be

developed readily, if high standards are held up as worthy ideals.[4]

29. A Feeling of Self-Reliance or Confidence in One's Ability to Take Care of Oneself in an Unusual Situation. This involves a feeling of mastery over material things, and a belief in one's ability to modify materials to meet his needs, as well as ability to meet people successfully in social and business intercourse. These come only through carrying responsibility, and meeting and dealing with people in a business and social way, and a more or less extensive and successful experience in handling materials, tools, and machines. The more extensive the experience, the greater the confidence in one's ability. We must, in a careful and systematic way, provide situations which will give adequate opportunities for these experiences. We cannot leave this training to chance experiences or accidental contacts. There must be a definite place in the program for such training.

30. A Habit of Orderly and Methodical Procedure in the Performance of Any Task. This involves two things: (1) A careful examination of the job or task to be done in order to find out exactly what is required; and (2) the formation of a definite step-by-step plan for doing the job, before starting on the task. This habit of work is so important that, in order to establish it, we should make it a conscious part of every school task. If this habit can be established in school, and carried over into outside work, you will have performed a service of inestimable value to the youth, whatever may chance to be his vocation.

[4]See Chapter XI, p. 238.

31. Knowledge and Understanding of the Conventions of Mechanical Drawing, and Ability to Express One's Ideas Accurately by Means of a Drawing. The working drawing is a universal language understood by the skilled workers of every nation. It is briefer and more accurate than any written or spoken language, and is capable of expressing relationships and conveying ideas that are quite beyond the power of the most highly developed written language. It can be learned in a short time and ranks next to our mother tongue in importance as a language.

32. Elementary Skills. *Elementary skills in the use of the more common tools and machines, and in the methods of modifying and handling materials, in order to make them conform to our needs.* This training should begin with the tools and materials most frequently used, and extend as far as the particular situation appears to demand and time will permit. In the case of those tools less frequently used, an experience sufficient to give a clear understanding of how processes are performed is adequate for most purposes, as skill in their use may be developed through practice when occasion for their use arises. If, however, we wish to develop a feeling of ease, readiness, and competence, in the use of tools, we must have practice with them until we can use them with pleasure and satisfaction. No one can feel at ease when handling unfamiliar tools and materials, or when working in an unfamiliar situation.[5]

It is by no means necessary, as some suppose, that the pupil should have training in the identical things

[5]See Chapter XI, p. 238.

he may be called upon to do and in the identical situations in which they occur. The ability to perform the rather unspecialized mechanical duties of the vast majority of men does not depend so much upon a highly developed skill as upon a knowledge of the qualities and characteristics of materials in common use, the methods of modifying or handling them, a knowledge of some of the most used principles of construction, an understanding of the principles upon which machines operate, and some of the rather elementary skills in the use of common tools.

33. Skill in the Industrial Arts. Skill is a relative term, and we do not expect to develop it to a high degree in industrial-arts work, but we ought to develop enough to give some confidence in the use of tools. The student should realize that the unaided hand is wholly incapable of doing the work of the world, and that he increases his power with the increase in his ability to use tools and machines. *To know how to do a thing* is the first step in the development of skill; *to be able to do it efficiently is skill.* The first comes through knowledge and understanding; the second comes through long practice. Much of the industrial-arts work must be concerned with the first step, but the second must not be neglected. The degree of skill to be developed will be determined by the demands in the different fields. A highly developed skill is soon lost through disuse; in like manner, a skill may be quickly developed through practice, if its elements are thoroughly understood.

The divisions suggested constitute only the major classifications under which must be placed the detailed

lists of the things we wish to teach. When this is done, the next step is to devise an arrangement which will develop or create a desire on the part of the pupil to learn them. This can be done through providing interesting experiences involving the things to be learned. It is obvious we cannot learn to use tools without using them. We cannot develop confidence and pride in our ability to do without some experience in doing. It, therefore, appears necessary to have experience with tools and materials, and to have opportunities and responsibilities for planning and doing things. The best place to get this in a systematic way is in the school shop.

It will be observed that the purposes presented here fall into two general groups or classifications; those which may be realized mainly through information, observation, a study of the things we use, and a contact with industry and people; second, those in which manipulative skills are involved in the use of tools, construction, the care and operation of machines, and in the demonstration of the application of mechanical principles to industrial processes. The first group does not necessarily involve shopwork, but the second group does.

34. What Type of Shop? The next question presented, and one which has troubled many teachers and school officials, is, "What type of shop shall we have?" There are many factors involved in the answer to this question. Perhaps the first step in the solution of the problem is to point out that the real question is not, "What type of shop?", but, "What arrangement and what available work will give us the best opportunity

to teach the things we have placed in our list of things we wish to teach?''

The answer to this question involves an entirely different approach. Instead of selecting a particular type of shop, we determine what we will do on the basis of what we wish to teach. When we examine the field from this standpoint, it will be found that any one of a great many activities may contribute almost equally well to these ends, if wisely chosen and well organized; but the activity must be chosen because of its positive and direct contribution. It will be observed that while skills are important they do not constitute a major portion of the training program.

35. Many Lines of Activity May Be Employed. It is evident that certain experiences will contribute more than others to some of the desired ends, but the degree of contribution may be governed to some extent by the method of presentation. Many of the things we wish to teach are common to every line of industry available for use in the schools. It is only in the technical elements, the skills, and the material that they vary. Those large elements, like planning, pride in workmanship, caring for the things we use, and interest in industry, may be developed with one kind of work almost as well as with another. In proclaiming the virtues of certain lines of work to the exclusion of others, we have been much like the blind men who went to see the elephant. The one who got hold of the elephant's tail maintained that the elephant was like a rope; the one who touched his side insisted that he was quite like a house; while the one who got hold of his leg stoutly maintained that he was like a tree.

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In our groping around we failed to get the larger vision, and have not recognized that there are many fields of activity which will afford us almost equal opportunity to teach the things we wish to teach. For example, work with wood may be so arranged as to involve many of the things we wish to teach. It is one of the most common materials used in construction, and is easily shaped and made to conform to our use. It, also, is one of the materials most easily and commonly used by the average man. Many of the tools involved in its use are the common tools of every household. Its production and manufacture form an interesting story. Its use in projects involves a number of other materials, some of the fundamental principles of science we wish to teach, and an opportunity to teach certain principles of design and construction in that field. Successful work with this material will tend to develop confidence, self-reliance, and pride in workmanship. It offers an excellent opportunity to develop the habit of planning. It fails, however, to meet some of our important needs. It offers little or no opportunity to study the various kinds of machines and mechanisms, and it is only one of the important industrial materials.

Work with iron offers many of the opportunities that wood offers. It is an important and much used material. A study of its production, manufacture, and use should be of great value in arousing interest in industrial affairs and in giving experiences that will aid us in understanding the things we use. It is the material most generally used in machines and mechanisms, and from that standpoint its qualities and characteristics

are highly important. However, it falls short of our requirements in at least one important respect: it is so difficult to manipulate that the average man has little to do with forming it or modifying it to meet his needs.

In like manner, electrical work, printing, or any other division of work based upon a single material or a single vocation is likely to be deficient in some respects, but if they are properly organized and supplemented, almost anyone of them will cover a large part of the field.

It does not follow from this that we should have work in but one field, nor that we should provide courses in a large number of fields. It does mean, however, that it is not necessary to go to large expense to provide equipment for training in a great many lines when the essential things may be taught in one line with a small amount of supplementary work to make up the deficiency.

There certainly can be no objection to teaching the things we wish to teach through a great variety of activities, but it is by no means necessary to give courses based upon a few simple jobs abstracted from four or five of the skilled trades. Most of the so-called exploratory or finding courses have been promoted by school men who are so far removed from industrial contact that they do not realize that the number of industries that can be adequately represented in the shops of any school is but a drop in the great ocean of industry. It is not the purpose of the work to give practice in the elementary skills of a variety of industries; but to give certain information and develop cer-

tain attitudes and habits that are valuable and important in any industry.[6]

In view of this, our choice of the kind of work may be governed largely by such factors as expense, local interest, and adaptability to the needs of the particular community. The one unfailing measure is, "Does it afford the best available opportunity to teach the things we wish to teach?" This can be determined only by careful analysis and the checking of every detail of the teaching program against it. If it meets the test, the classification as to the type of shop is immaterial.

These statements of purposes form only the general headings under which we must group the specific things we wish to teach. For example, it is not sufficient to say we will teach something of the qualities and characteristics of wood; we must list the particular qualities and characteristics we expect to teach. It is not sufficient to say that we will teach an appreciation of good design; we must be much more definite by listing the types of design and the elements involved. It is not sufficient to say that we will teach certain elementary skills; we must list the skills we expect to teach. Local conditions will lead to variations in these detailed lists, but the things selected must always be chosen with a view of their contribution to the major purposes.

36. Trade Training Is Intensive and Narrow. In the industrial arts our main purpose is to give information and training with respect to industrial facts and processes that will tend to promote interests and

[6]See Chapter XIV, p. 287.

establish habits of thought and action that will be of value to the individual without respect to his future vocation. This is necessary because we have no means of determining in what vocation he will engage. Obviously, if we succeed in our purpose, the training will be of value to one who decides to engage in a skilled trade. While such work offers an excellent basis for the training for a trade, it is not trade training in either purpose or character. In trade training we try to develop a high proficiency in a narrow field, and in order to do so we place emphasis on the elements in that particular field because we know they are constantly needed in that vocation. In order to give this emphasis we are willing to ignore many matters not directly related to the trade.

For example, we wish the boy in trade training to have a broad, general interest in industrial affairs, but we are willing to sacrifice some of this broad, general interest in order to develop a greater interest and a more detailed knowledge of the industry in which he is to engage. It is important that he have a thorough knowledge of the scientific principles affecting the work of his trade, even to the neglect of the principles that affect success in other trades. We wish him to have pride in his ability and skill as a workman, but we are quite satisfied if he has it to a high degree with respect to his own trade.

In the training for a specific trade the tendency is to neglect those success factors such as attitudes and habits of work that are common to many trades, and to emphasize only those things which distinguish the training as being for the specific trade. These things

consist of the skills and information required to do well the work within that special field.

The training of a boy for a trade is bound up in three things:

1. *What we wish the boy to be.*

This consists of those habits and attitudes that make for good citizenship. These are not necessarily part of the trade, but there should be a conscious effort to develop them in connection with the acquisition of information and the development of skills.

2. *What we wish him to know with respect to the trade.*

This consists of the general information, scientific principles, and the general practices of the trade, a knowledge of which is necessary in order to plan successfully the jobs he must do and enable him to meet new and unusual situations. It is one of the chief marks of distinction between the resourceful, high-grade mechanic, and the workman who can do only what he is told to do.

3. *What we wish him to be able to do with respect to his trade.*

This consists of the skills involved in the practice of the trade which is sometimes thought of as being the whole of trade training. Skills are important and should never be neglected, but tool skills may be acquired in a relatively short time. They consist of well established habits, and if the laws of habit formation are observed during the period of instruction the time required for learning may be greatly reduced.

One of the reasons it takes the apprentices so long to acquire the skill of his trade is that the laws of

learning as applied to habit formation are not understood by the people who train him, or the conditions are such that it is thought they cannot be observed. The planning, the ability to look ahead, to know what constitutes satisfactory and safe conditions, the general practices of the trade, and things of that nature, are more difficult to learn and are more important from the standpoint of success than mere skill with tools. There usually is a place for the man who can do well the specific things he is told to do, but the rewards are much greater for the man who can plan his work, and meet successfully new and unusual situations.

37. Summary. The individual develops through his experiences. In order to develop him into the thing we wish him to be we must provide experiences which will contribute to that end. That is the purpose of our schools.

The first step in the program is to determine what we wish him to be. The present organization of school work limits our program largely to the industrial or doing side of life. Since we do not know the vocations in which the individuals will engage it is necessary to give them experiences that will be of value to them without respect to their vocations. These purposes, for the development of which experiences must be provided, are as follows:

1. *A well developed interest in industrial affairs.*
2. *How to care for and use properly the things we buy.*
3. *An appreciation of good workmanship and good design.*
4. *An attitude of pride or interest in one's ability to do things.*
5. *A feeling of self-reliance or confidence in one's ability to take care of oneself in an unusual situation.*

6. *A habit of orderly and methodical procedure in the performance of any task.*

7. *Knowledge and understanding of the conventions of mechanical drawing, and the ability to express one's idea accurately by means of a drawing.*

8. *Elementary skills in the use of the more common tools and machines, and in the methods of modifying and handling materials, in order to make them conform to our needs.*

Every experience provided should be selected because it is believed it will make a positive contribution to one or more of these desired ends.

Trade training is given with a view of developing a high degree of efficiency in a narrow range of activities. It is limited to those experiences which will contribute to the individual's success in his particular vocation.

The training for a trade is bound up in three things:

1. *What we wish the boy to be.*
2. *What we wish him to know with respect to his trade.*
3. *What we wish him to be able to do with respect to his trade.*

When these things are determined we should select experiences which will make a positive contribution toward the realization of such purposes.

38. Observation Problem. Careful and systematic observation is an essential step in the training of teachers. It will do much to reduce errors and add to the confidence of the beginner. The conditions of observation will vary in different teacher training institutions, and it is, therefore, quite impossible to give general directions for observation which will fit all situations. The teacher trainer, however, should provide each observer with a list of general directions and regulations covering the situation in the particular school. These will include such things as, conference with the supervisor, conduct in the classroom, attitude

toward teacher and pupils, and any other instructions that may be necessary in order to obviate difficulties and secure uniformity in practice. In addition to these general instructions, the observer should be assigned a specific observation problem, definitely outlined, on which he will be required to make a formal report.

Assignment: Go to the classroom assigned, observe the work, and make a report covering the following points:

1. Is the work given to provide experiences that will be of value without respect to the future vocation of the pupils, or are the experiences confined to a narrow field for vocational purposes?
2. Observe carefully the experiences the pupils are getting, and make a list of those that you believe make a positive and valuable contribution to one or more of the eight main purposes.
3. Show in what way they contribute either through content or method of presentation.
4. Make a list of those experiences the contribution of which you believe to be of doubtful value, and give your reasons for such conclusion.
5. If it is a trade class, are the members of the class fully aware of the learning units involved in the trade?
6. Are the experiences so chosen as to give adequate training in these elements of the trade?
7. Give examples and suggestions for any changes you think desirable in the content or method of presentation.

QUESTIONS—CHAPTER III

1. What is the fundamental purpose of our schools?
2. How shall we determine what we shall teach?
3. Why should we try to create or develop an interest in industrial life?
4. Is it wise to provide a wide variety of work in the industrial-arts shop? Give reasons for your answer. What conditions might affect your policy in this respect?
5. If you could have but one line of activity, what would it be?
6. Tell how you would make it contribute to each of the main purposes of industrial-arts work.
7. Give three other lines of activities that you consider valuable as contributing to these ends, and indicate just how and in what manner each would contribute.

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CHAPTER IV

Analyzing Our Task

39. The Individual. An individual is the product of his natural endowment plus experience. We can not remove the limits placed upon him by his inheritance, nor can we create for him, or implant in him, abilities which nature did not give. Nature allots the raw material, and we can not change it in quantity or quality. We may, by careful training, make it more useful, and develop it into its highest possibilities, but nature has set the limits. From a few pounds of crude iron ore we may make a piece of good steel, but we cannot make tungsten steel without the tungsten. The improvement of the individual must come through refining and developing the raw material which nature has supplied.

The refinement and development of the abilities of the individual can come only through experience. If the experiences are wisely chosen, the development will be favorable; if unwisely chosen, the development may be retarded, or it may be along undesirable lines. The function of the school is to provide experiences which will develop the individual into what we wish him to be.[1]

40. Discover the Qualities and Characteristics of Individuals. The first step in such a program is to discover the qualities and characteristics of the material with which we are to deal. Through our testing program we have made a start in developing methods

[1]See Chapter X, p. 210.

for discovering the native abilities and mental equipment of individuals. While these methods or devices are, at present, more or less inadequate, the progress we have made justifies the hope that sometime we may be able to develop a system of measurements which will enable us to determine with a rather high degree of accuracy the native potential abilities of the individual. When these have been determined as accurately as our measuring devices will permit, we may apply achievement tests which will measure with reasonable accuracy the effect of the individual's experience in the field in which we are interested. This will give a fair knowledge of the material with which we are to work. Such a checking of our material in advance would save a great deal of time and many bitter disappointments.

41. Determine What We Wish the Individual to Be. Our next step is to determine what we wish the individual to be when he has completed his period of training with us. With a more or less accurate knowledge of the abilities and characteristics of the individual; knowing the degree of his accomplishments in the particular field; and having a clear statement of what we wish him to be when he has finished our period of training; we are confronted with the task of choosing the experiences which will contribute most directly and most positively to that end.

Modern science is based upon analysis. When confronted with a problem, we immediately set about the task of systematically separating it into its parts, and then make a careful examination of each part. Chemistry has taught us how to break down numberless com-

pounds and combine the units in new ways and produce new materials. So, in education, we must analyze our problems into the smaller units in order to classify them and to be able to handle them with greater satisfaction and assurance.

The casual observer sees things as a complete unit, but the builder must see the parts which compose the finished product. The ordinary observer sees the individual as a cultured, refined, and agreeable person, but he does not see the elements, the infinite number of little things, that go to make up this satisfactory personality. He realizes in a vague way that there are many attitudes and accomplishments involved, but he does not know just what they are. It is the business of the teacher to discover the individual elements that constitute the desirable characteristics in the individual, and to give to the pupil experiences which will develop them. The selection and listing of these characteristics and accomplishments is the teacher's analysis of his task. The experiences chosen for the purpose of developing these activities and training in these accomplishments may be selected from a multitude of things in the industrial field, as in the industrial arts, or they may be selected from a very restricted division of industry, as in trade training.

42. Choose Experiences Which Will Give Training in Accomplishments Desired. In Chapter III we have discussed the general aims and purposes of the industrial arts and of trade training. These general aims represent the habits, attitudes, interests, skills, and knowledge which we expect the individual to have as a result of our instruction. As such they constitute our

most serious purpose, and are not mere formal statements of vague and indefinite professional longings. We must proceed with a most earnest and determined purpose to realize each of these ideals to the very highest possible degree.

In order to do this we must choose from the field of life the experiences which contribute most to their realization. In this choice we should not be restricted by tradition, nor by practice. The field of life is spread out before us, and we must select from it the experiences which will contribute most to these ends. We need not be concerned about their classification. It will be found that some experiences contribute generously to all of our different aims. In other cases, the experience may contribute largely to one of our aims and scarcely at all to any of the others. Such an experience need not be rejected for that reason; but, other things being equal, experiences should be chosen which will contribute to as many of our primary aims as possible.

Local conditions often will determine the character of the experiences to be given, not primarily because of a different purpose, but because local conditions may afford opportunities for a different kind of work which may contribute equally well to the end sought. In making our selection there are two fundamental conditions to be met: The experiences must contribute to the realization of our ideals, and they must be of such a character that they may be conveniently acquired under local school conditions.

When once the character and type of experience is determined upon, the teacher should separate it into convenient units of instruction, or learning units, and

arrange his presentation so that the experience will contribute as much as possible to his primary purposes.

43. Units of Instruction Not Separate and Unrelated. When confronted with the problem of training individuals in any field of knowledge, or accomplishment, it becomes necessary to break up the field into convenient learning units. The field, taken as a whole, is too large and too complicated to be handled as a unit. These units of instruction are not to be regarded as separate and unrelated things, but as essential elements of the whole, a part of a larger plan. It is important that they be selected with great care, and it is equally important that those whom we are to teach should thoroughly understand the relation of these units to the larger task. They should be recognized as the definite steps in the major objectives toward which the pupil works. To the teacher they are instruction units; to the pupil they are learning units. The teacher's plan should be developed with the idea of teaching these things in the most effective manner.

44. Many Factors Affect Size of Teaching Units. There are many factors which affect the size of the teaching units. One of the most important of these factors is the advancement of the student, or his experience in the particular field. The units must always be sufficiently simple to be within his grasp, and sufficiently difficult to inspire him to his best efforts. In the beginning it is very important that the units be simple, but his ability will increase with his experience and advancement in the subject, and the later units may be relatively much larger, and based upon the assumption of certain elementary knowledge or expe-

rience gained from his training in previous units.

For example, one of the early units of instruction in the machine-shop is, "How to Center Stock for Mounting Between Centers," and knowledge of this unit may be assumed in a subsequent unit of instruction, such as, "How to Turn a Taper." In the latter case it would not be necessary to repeat the instructions given in the former unit. There are a few fundamental processes in every trade, which occur in almost every job of the trade, which should be taught early, and a knowledge of which may be assumed in subsequent instruction units just as we assume a knowledge of the fundamental operations of arithmetic in subsequent instruction units in that subject. Instruction in these fundamental units should always be available for those who forget, or for those who are not well grounded in them.

45. There Should Be a Feeling of Unity Concerning the Subject of Instruction. Another important factor in determining the size of the unit of instruction is the essential unity of the subject matter. The unit must be so selected that there is a feeling of completeness about it when finished; and there must be a feeling, also, that it was of sufficient importance to be worth while.

46. Length of Recitation Does Not Determine Size of Unit. The size of the teaching unit cannot be determined by the length of the recitation period. The time required for the presentation of one unit may be but a few minutes, while the presentation of another unit of the same subject may require two or more lesson periods. The essential thing is that the student should

feel that there is a unity in the presentation, just as he would recognize the unity in a story. It may be a short story which he can complete without interruption, or it may be a continued story as in a magazine. In either case he would have a sense of satisfaction at the completion of the story, and be fully aware that it is not complete if it is interrupted before the end. Lack of this feeling of unity concerning the teaching unit often is a source of difficulty for the student. It is like learning a lot of nonsense words.

47. Jobs Not Satisfactory Units of Instruction. It is not often that a job can be treated as a unit of instruction. It is too complicated, and contains too many elements in which the pupil may require instruction. Jobs are not the things to be taught; rather, we wish to teach the elements that make up the job. This is an important distinction. The instruction unit deals with a principle or an operation that is more or less general in its application and is not limited to one particular job. For example, "How to Apply Paste Filler," is an instruction unit which is involved in many jobs of finishing, and while it may be taught in connection with the job of finishing a library table, the instructions should be so prepared that they may be used equally well in the job of finishing a desk or in finishing a hardwood floor.

In teaching, these instruction units are not presented as separate and unrelated things, but the instructions should be prepared without reference to a particular job, and should be so written that they will apply to any job in which this element is involved. This makes it possible to use a great variety of jobs as a means of

teaching, gives great flexibility, and emphasizes the things to be taught. The units of instruction in a trade may be generalized just as they are in arithmetic. When making a rule for placing the decimal point in multiplication we do not make it apply to one problem only, but we state it so it will apply to all problems involving the multiplication of decimals. We teach it by requiring its application to a great variety of problems in which it is involved, and do not confine its use to any particular list.

It is important to remember that the units of instruction in any field are incomparably fewer in number than the problems or jobs in which they are involved. Consider how the number of fundamental units of instruction in arithmetic compare with the number of problems in which they are used. Consider, also, how the fundamental units of instruction in carpentry, such as sawing, planing, nailing, compare with the number of jobs in which these units of instruction are involved. The units of instruction consist of the things we wish to teach; the problems or jobs offer a variety of more or less interesting opportunities to teach them.

48. Job-Analysis or Duty-Analysis of a Vocation Inadequate. The analysis of a vocation on the basis of the jobs or duties one may be called upon to perform if he is engaged in that vocation is wholly inadequate from the standpoint of determining what should be taught. An analysis for teaching purposes must list the things one must know and be able to do in order to perform these duties. For example, it may be the duty of a court reporter to report the testimony of the defendant in a murder trial one day and the testimony

of the defendant in a robbery case the next, but a statement that these are some of the duties of a court reporter does not indicate the character of training we should give the individual in order that he may perform those duties.

One of the duties of a pharmacist may be to compound a prescription for rheumatism, but from the standpoint of teaching we are interested in what he must know in order to do it properly. A printer may have a job of printing an engraved wedding invitation one day, and an engraved invitation to a birthday party the next, but to list these jobs does not indicate in what he should be trained in order to do them in a satisfactory manner.

A duty-analysis defines the general limits of activity in the vocation, and would be valuable in settling jurisdictional disputes of labor unions where a question of whether filling a nail-hole in the plaster is the duty of the decorator or the plasterer, but it does not indicate the training one must have in order to perform the duty. It has a value, also, in setting the limits to which the analysis for teaching purposes should go, but it should not be mistaken for a list of the learning units of the vocation. It indicates the limits of the teaching field, but does not tell us what to teach.[2]

49. We Must Have a List of the Things We Wish to Teach. One of the most profitable things a teacher can do is to ask himself the question: "What do I expect my students to be, to know, and to be able to do at the end of the year, as a result of their experience and my

[2]Charters, W. W., *Review and Critique of Curriculum Making for the Vocations,* Twenty-Sixth Yearbook, N.S.S.E.

teaching in this subject?", and then to answer the question unbiased by speculative theories or fanciful hopes. It is of no particular value to state these things in terms of general objectives, large and incomprehensible units, or indefinite and high-sounding phrases. They should be stated in terms so simple, so definite, and so exact, that every pupil may understand them readily. Such a statement supplies definite goals, both for the teacher and the pupils, and when a student knows exactly what he is expected to do he is much more likely to do it than when a requirement is hazy and indefinite. This applies to every subject in the curriculum, and the failure to have such a list leads to aimless wandering and enormous waste of time.

It may be granted that to write out such a list is a difficult task, but unless one can make a list of the principal things he expects a pupil to know when he has finished his period of training, the chances are the teaching will be indefinite and uncertain. In shopwork it is likely to result in simply making things, and in other classes it is likely to be governed by the text rather than by the needs of the pupil. It is by no means necessary that the list be a complete one in the beginning, but it should be made as complete as possible; and then when some new point arises, it may be added to the list. In this manner the list soon becomes quite complete. Sometimes an item may be placed in the list which it is not feasible to teach. In such cases it should be struck out.

In order to illustrate what is meant, and to give some suggestions for working out the plan, we undertake to answer the question for woodworking for boys

at the end of the ninth grade. This list may not be as complete as it should be, or it may contain things that we should not expect of the boys; but such a list offers a basis for work, and any teacher may add to it, take from it, or substitute in any way necessary to adapt it to his particular requirements. The list given contains only those things involved in working with wood, including some units in wood-finishing. The teacher should add units from other fields in order to enrich the course. The important thing is that when he has finished working on the list he may be able to say, "These are the things that I expect the boys to know and to be able to do at the end of the period of training."

The principal, the teacher, and every boy should have a copy of this list, and it should be understood that the boys will be checked by this list at frequent periods throughout the year and at the end of the year. To the boy it will be a definite list of the things he must learn; to the teacher it will be a definite list of the things he must teach; and to the principal or administrative officer it will be a list by which he may check the success of the teacher and the progress of the boys. It will no longer be necessary to judge the progress of the boys by the amount of repair work done on the school building, the number of pieces of furniture made, or the amount of material used.

Such a list will reveal to the principal that the primary purpose is to *teach* something rather than to *make* something, and this will be a new point of view to many principals.

We should not overlook the fact that this list repre-

sents the boy's accomplishments at the end of the ninth grade, and not what we expect to teach him in that grade. The items on the list that we will have to teach him in that grade will depend upon his previous training and experience. If he has had shopwork in other grades, or if he has had much outside experience, he will know many of these things. At as early a date as possible we should determine his proficiency in any of the items in which he believes himself to be proficient, and if found so he should be given credit. The recognition of individual accomplishments is an important factor in developing morale and a desire for further progress.

50. Arrangement of List of Things to Be Taught. It is not necessary to arrange the list in the order of difficulty. That pedagogical half truth, that the "material of instruction should be arranged in the order of learning difficulty," has been repeated so often and with so much authority that it is generally accepted as the whole truth. In our love for fine phrases we forget that importance and frequency in use are first considerations. For example, it probably would be granted that it is easier to learn to spell the word "ken" than the word "receive," but in preparing a list of words that a child should learn to spell we would not place "ken" before "receive." It is better to arrange the items with some respect to their frequency and importance in use. A thing that is to be used frequently should be taught early in the course even though it is more difficult to learn than a thing that is used rarely.

During the process of analysis it will be found that

certain learning units are in reality jobs. For example, "How to Sharpen a Plane-Bit" is a learning unit, and it is also a job quite independent of any other job. It might be necessary in connection with any job in which planing is involved, but we could not in advance attach it to any particular job and feel sure that it would be needed at that time. The same would be true of filing a saw. In view of this it is well to place such learning units in a group at the bottom of the list of operations to be learned

It will be found that pupils make very unequal progress, and we may not expect all of them to reach the same point in our list. In order to take care of this difficulty, and to meet the usual requirements of grading, passing, and failing, it is advisable to divide the list into about three divisions, and to state that every boy is expected to complete the first group, that the good workers will complete the first and second groups, and the exceptionally good workers will be able to complete the entire list.

The following lists of learning units suggested for junior high school have been arranged under familiar titles as a matter of convenience. It is not intended, however, that a teacher should take any one of these lists and follow it through to completion to the exclusion of the others. The teacher should select from the various lists, or from any other source, the things he wishes to teach the boys during the period of training, and compile his own list. The items of such a list would be determined to some extent by local conditions.

For example, the teacher may conclude that in view of his equipment and the general situation in the com-

munity it is desirable to select a major portion of the things to be taught from the field of woodworking, but he should not feel that it is necessary to teach all the items in that list. He might build up his list by selecting the major portion of his items from the field of woodworking with some from the lists of electrical, sheet-metal, and drawing units, and select his projects so as to include those things. This plan will enable the teacher who has equipment based upon woodworking to broaden the course at comparatively small expense, and without administrative difficulty. It is much more flexible than the use of the six-activity general shop where a specific amount of time is given to each activity, and it is just as effective from the standpoint of giving a broader view of industrial life.

The following examples of lists of learning units have been compiled as a result of an extensive inquiry among teachers, and students in teacher training institutions. They are given, not as complete lists of learning units in these subjects, but rather as a starting-point. Some teachers may desire to change the titles of some of the units somewhat, others may desire to omit certain of the units as relatively unimportant, and still others may wish to add to the list.

51. The Woodworking List. The first illustration is drawn from the field of woodworking, and is more complete than the illustrations from the other fields, not because of the importance of woodworking from a teaching standpoint, but because more people are familiar with woodworking processes and woodworking tools than with the tools and processes in any other industry, and it is believed that our illustration drawn

from this field will be understood and appreciated by more people than one drawn from any other field.[3]

WOODWORK

During the year you will have an opportunity to learn the following things. When you have shown proficiency in any one of them you will receive credit on the Progress-Chart.

THE THINGS YOU ARE EXPECTED TO BE ABLE TO DO

1. Read a working-drawing.
2. Make out a bill of material.
3. Plan the procedure for doing jobs.
4. Check all material when received.
5. Measure and divide spaces with a rule.
6. Use a pencil, or a knife, in laying out work.
7. Use the dividers, or compass, for laying out curves and dividing spaces.
8. Gage with a marking-gage, or a pencil.
9. Use a try-square for laying out square cuts and for testing.
10. Adjust a plane.
11. Plane a surface true.
12. Plane end grain.
13. Square up a board.
14. Lay out pattern on stock.
15. Saw to a line.
16. Use a coping-saw for inside or outside curves.
17. Finish outside curves.
18. Finish inside curves.
19. Drill holes in wood.
20. Countersink holes.
21. Trim with a chisel.

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[3]Examples of the analysis of trades for their instruction units will be found in the following publications:

R. W. Selvidge, *How to Teach a Trade,* Chapters III and VII.
R. W. Selvidge, *Individual Instruction Sheets,* Chapter III.
Selvidge and Allton, *Blacksmithing.*
Selvidge and Witt, *Instruction Manual for Young Printers.*
Selvidge and Christy, *Instruction Manual for Sheet-Metal Workers.*
Castle, *Problems in Blueprint Reading.*
Kelsey, *Principles of Automechanics.*

22. Use sandpaper properly.
23. Fasten with screws.
24. Drive and draw nails.
25. Set a nail or brad.
26. Use a scraper.
27. Bore holes with an auger-bit.
28. Use a T-bevel.
29. Lay out and plane a chamfer.
30. Put on cupboard locks.
31. Put on hinges.
32. Apply stain.
33. Clean and care for stain-brushes.
34. Apply stain for two-tone effect.
35. Apply fillers.
36. Apply shellac.
37. Clean and care for shellac-brushes.
38. Apply wax.
39. Apply varnish.
40. Clean and care for varnish-brushes.
41. Apply enamel.
42. Clean and care for enamel-brushes.
43. Apply lacquer.
44. Clean and care for lacquer-brushes.
45. Transfer a design.
46. Lay out irregular design by means of squares.
47. Prepare glue.
48. Glue up work.
49. Use handscrews and clamps.
50. Use a spokeshave.
51. Lay out duplicate parts.
52. Make a butt-joint.
53. Make a notch-joint.
54. Do simple upholstering.
55. Lay out and cut a dado-joint.
56. Cut a groove or a rabbet.
57. Lay out and cut a cross-lap joint.
58. Lay out and cut a miter-joint.
59. Make a dowel-joint.
60. Lay out and cut a blind mortise-and-tenon.
61. Lay out and cut a through mortise-and-tenon joint.
62. Construct a panel.
63. Lay out and cut a housed joint.

64. Make an edge-to-edge glued joint.
65. Make a drawer-slide.
66. Make and fit a drawer.
67. Fasten on a table-top.
68. Sharpen edged tools, such as knife, chisel, and plane.
69. Sharpen a screwdriver.
70. Sharpen a scraper.
71. Sharpen auger-bits.
72. Sharpen a saw.

Only learning units involving hand processes have been listed, but if it is considered desirable to teach the use of woodworking machinery the learning units for that phase of the work may be arranged as follows:

The Jointer:

1. Safety rules for operating jointer.
2. Range of work which may be done on the jointer.
3. How to care for and adjust the machine.
4. How to joint an edge.
5. How to make a spring joint.
6. How to surface narrow stock.
7. How to take the wind out of a board.
8. How to cut a rabbet.

The Circular Saw:

1. Safety rules for operating saw.
2. Range of work which may be done on the saw.
3. How to care for and adjust the saw.
4. How to rip.
5. How to cut off.
6. How to cut grooves.
7. How to cut dadoes.
8. How to cut tenons.

The Band-Saw:

1. Safety rules for operating the band-saw.
2. Range of work which may be done on the saw.
3. How to care for and adjust the saw.
4. How to saw curves.
5. How to rip.
6. How to cut off.

The Turning-Lathe:

1. Safety rules for operating lathe.
2. Range of work which may be done on the lathe.
3. How to adjust and care for the lathe.
4. How to center stock.
5. How to mount work between centers.
6. How to rough down with a gouge.
7. How to smooth with a skew-chisel.
8. How to lay off pattern of piece.
9. How to size with a sizing-tool.
10. How to mark off with skew-chisel.
11. How to use a cut-off tool.
12. How to cut tapers with a skew-chisel.
13. How to cut beads or convex surfaces with a skew-chisel.
14. How to scrape with a skew-chisel.
15. How to scrape with diamond-point and scraping tool.
16. How to measure with outside calipers.
17. How to measure with inside calipers.
18. How to cut concave curves with gouge.
19. How to use templets.
20. How to mount work on a face-plate.
21. How to mount work on a screw-chuck.
22. How to size work on a face-plate.
23. How to hollow out work on the face-plate or screw-chuck.
24. How to fasten pieces together temporarily for turning.
25. How to cut off stock in the lathe.
26. How to sandpaper in the lathe.
27. How to apply finish in the lathe.
28. How to make a hollow chuck and mount work in it.
29. How to make a spindle chuck and mount work on it.
30. How to make a set-up for duplicate parts.

THE THINGS YOU SHOULD KNOW

I. *Concerning lumber:*

1. You should be able to identify the following kinds of lumber and any other kinds in common use in the community: The pines, spruce, cypress, oak, walnut, birch, maple, mahogany, cedar, hickory, gum, chestnut, poplar.

2. You should know the principal characteristics, the working qualities, the principal uses, and the sources of supply of each.

3. You should know the methods of cutting and milling lumber.

4. You should know how lumber is dried.
5. You should know the effect of moisture on wood.
6. You should know the standard dimensions of lumber and how classified.
7. You should know the nominal and actual dimensions of lumber.

II. *Concerning finishes:*

1. The object of finishes.
2. The kinds of finishes, such as: stain, oil, wax, shellac, varnish, lacquer, enamel, paint.
3. The durability of different finishes.
4. The conditions or places in which various kinds of finishes may be used to advantage.
5. Materials from which finishes are made.

III. *Concerning glue:*

1. Kinds of glue.
2. The preparation of glue.
3. The conditions and requirements in use.

IV. *Concerning nails:*

1. The kinds of nails.
2. The uses of the different kinds.
3. The sizes of nails.
4. How nails are sold.
5. How nails are manufactured.

V. Concerning screws:

1. The kinds of screws.
2. The uses of the different kinds.
3. How the sizes of screws are indicated.
4. How they are sold.

VI. *Concerning sandpaper.*

1. The kinds of sandpaper.
2. Grades of sandpaper.
3. Principal uses.

VII. *Concerning styles of furniture:*

The distinguishing characteristics of different types of period furniture.

VIII. *Concerning the design of furniture:*

In the design of furniture you should develop a fair judgment with respect to the following:

1. Is it adapted to the use for which it is intended?
2. Is it structurally good?
3. Is it well made?
4. Are the structural members in good proportion?
5. Does it have an appearance of stability?
6. Is the structure as a whole well proportioned?
7. Are the outlines pleasing?
8. Is it well finished with an appropriate finish?

IX. *Concerning manufacture of wood products:*

1. The location of important manufacturing concerns.
2. The division of labor in the industry.
3. The use of automatic machinery.

X. *Kinds of grinding and sharpening stones, their grades and uses.*

XI. *Opportunities and requirements in Carpentry and Woodworking trades.*

WHAT YOU SHOULD BE

The following is a list of desirable attitudes and habits which will contribute to your success in life. You should consciously practice them until they become fixed habits.

1. *Industry.* This means a habit of careful, thoughtful work without loitering or wasting time.

2. *Cooperation.* This means an attitude of readiness to assist others when they need help, and to join in group undertakings.

3. *Consideration for others.* This means a thoughtful attitude in the matter of making things easy and pleasant for others, such as keeping things in order, putting tools away in good condition, and always doing your full share of work where others are involved.

4. *Self-reliance.* This attitude is a very important factor in success. It means that you should develop the habit of planning your tasks carefully and thoughtfully and carrying them out with the least possible assistance. Be sure the problem is too difficult for you before you call for help.

5. *Readiness to assume responsibility.* This means that you should not refuse to undertake a task because it is difficult, and when once undertaken you should carry it through to completion.

The list should be kept posted in a conspicuous place in the classroom as a definite goal of accomplishment for the year. Consider the advantage of such a definite list over such indefinite statements as, "The use and care of the principal woodworking tools." "A knowledge of construction problems." "The application of finishes, lumbering, etc." One of our principal difficulties in making our lists is the tendency, in nearly every instance, to make the units too large and too indefinite.

52. The Mechanical Drawing List. The second example is taken from the field of mechanical drawing.

MECHANICAL DRAWING

During the year you will have an opportunity to learn the following things. When you have shown your proficiency in any one of them you will receive credit on the Progress-Chart.

THE THINGS YOU ARE EXPECTED TO BE ABLE TO DO

1. Sharpen a drawing pencil.
2. Fasten the paper to the board.
3. Lay out the sheet.
4. Mark points with a pencil.
5. Measure with an architects' or engineers' scale.
6. How to use the T-square and triangles.
7. How to use the compasses.
8. How to use the dividers.
9. How to block out views.
10. How to make simple working sketches in two or three views.
11. How to choose and locate the views.
12. How to make working-drawings in two or three views.
13. How to represent a cross-section of an object.
14. How to draw an auxiliary view.
15. How to draw, and when to use, the different kinds of lines in drafting; as visible line, invisible outline, center-line, dimension-line, arrow-heads, extension-line, broken material, cross-hatching.
16. How to dimension a simple drawing.
17. How to ink a drawing.

18. How to use a ruling-pen.
19. How to check a drawing.
20. How to draw tangents to arcs.
21. How to bisect a line and its arc.
22. How to construct a hexagon on long or short diameter.
23. How to construct an octagon.
24. How to construct an ellipse.
25. How to divide a line by trial.
26. How to bisect an angle.
27. How to draw irregular curves.
28. How to divide a line into any number of equal parts.
29. How to transfer angles.
30. How to draw tangent arcs.
31. How to construct a triangle when the sides are given.
32. How to draw a circle through three given points.
33. How to draw an arc tangent to two lines which are not parallel.
34. How to draw an ellipse by the concentric-circle method.
35. How to draw an ellipse by the approximate method.
36. How to draw an ellipse by the pin-and-string method.
37. How to make an isometric drawing.
38. How to make an oblique or cabinet drawing.
39. How to measure with inside and outside calipers.
40. How to trace a drawing on tracing-paper or tracing-cloth.
41. How to make a blueprint from a tracing.
42. How to develop a pattern of a prism-shaped object.
43. How to develop a pattern of a pyramid-shaped object.
44. How to develop a pattern of a cone-shaped object.
45. How to develop a pattern of a cylindrical object.
46. How to draw standard conventions of threads.
47. How to draw a conventional bolt-head.
48. How to draw a conventional hexagonal bolt-head.
49. How to draw a conventional square nut.
50. How to draw a conventional hexagonal nut.

THE THINGS YOU SHOULD KNOW

1. The names and uses of the drafting instruments and how to care for them.
2. The kinds of scales used in measuring, and for what classes of work each kind is used.
3. The kinds and qualities of drawing paper and their uses.
4. The various grades of pencils and their uses.

5. How to select and care for the T-square and triangles, and when to use them.
6. The principles of orthographic projection.
7. How blueprint paper is bought and sold, and how to care for it.
8. How tracing-cloth and tracing-paper are bought and sold, and the use of each.
9. The kinds of ink used in drafting.
10. When to use sectional views, and the conventional ways of presenting them.
11. The kinds of pens best suited for lettering.
12. How to select and care for the drawing-board.
13. The conventional ways of representing breaks in materials.
14. What a title should contain.
15. Occupational information, including success factors, income, and opportunities.

53. The Sheet-Metal List.

SHEET-METAL

During the year you will have an opportunity to learn the following things. When you have shown your proficiency in any one of them you will receive credit on the Progress-Chart.

THE THINGS YOU ARE EXPECTED TO BE ABLE TO DO

1. How to plan a job.
2. How to make out bill of material.
3. How to transfer patterns to sheet-metal.
4. How to develop simple patterns.
5. How to use snips in cutting metal.
6. How to solder tin, copper, or galvanized iron.
7. How to light and operate a blow-torch or gas-furnace.
8. How to use the squaring-shears.
9. How to use the bar-folder.
10. How to turn edges for a hem.
11. How to punch holes.
12. How to rivet.
13. How to raise or bump sheet-metal forms.
14. How to give hammer finish to copper.
15. How to roll a sheet on forming-machine.
16. How to wire edges.
17. How to turn lock seams.

18. How to groove with a hand-groover or grooving-machine.
19. How to use burring-machine.
20. How to make a setting-down seam.
21. How to double seam on stake or machine.
22. How to crimp to shrink edges.
23. How to drill holes in metal.
24. How to tin a soldering-copper.

THE THINGS YOU SHOULD KNOW

1. Kinds of solder and their uses.
2. Kinds of fluxes and dipping solutions and their uses.
3. Names of sheet-metal operations, tools, and equipment.
4. Care of tools and equipment.
5. The gages of sheet-metal.
6. Standard sizes of soft iron wire.
7. Source and characteristics of tin.
8. Methods of manufacturing tin plate.
9. Commercial sizes of tin plate.
10. How galvanized iron is manufactured.
11. Commercial sizes of galvanized iron.
12. Source and characteristics of copper.
13. Composition of brass, its characteristics, and uses.
14. Occupational information, including the success factors, wages, opportunities, and conditions of industry.

Additional examples of analysis of high-school shop subjects may be found in the preliminary report of the Committee on Standards of Attainment in Industrial-Arts Teaching, American Vocational Association, published in the INDUSTRIAL EDUCATION MAGAZINE, Volume XXXI, No. 7, January, 1930, page 263.

54. Analysis Does Not Involve Exercise Method of Teaching. To some people such a list in a shop subject suggests the return to the old exercise method of many years ago, but such people usually are those who are not familiar with the actual conditions of shop-work, or, they have the idea that production is the primary consideration, and wish to state the objectives

of teaching in terms of jobs rather than in terms of things to be learned. It is considered rather old-fashioned to make a direct and positive attempt to develop skills, but we need not fear a thing because it has an ancient sanction. The decalog dates from a rather remote period, and yet we would not abandon it entirely. In method it may not conform to some of our modern educational theories, but its effectiveness might suggest something with respect to form.

With all its shortcomings we should not overlook the fact that the old exercise method was based upon a pretty thorough analysis for the purpose of picking out the fundamental processes to be taught, and that its principal weakness lay in the fact that these processes were taught as isolated things and not in connection with their application in a productive undertaking. The resulting difficulty was not so much a lack of interest in the work, as is generally supposed, as it was a lack of ability on the part of the pupil to appreciate the importance of the processes or to give them a practical application. The idea of the shop exercise was quite in keeping with the educational theories of the time in which drill and discipline were regarded as fundamental.

55. The Doctrine of Interest. Our educational history shows a remarkable reaction from this point of view. The doctrine of interest became the vogue, and we swung to the other extreme. In some quarters it was held that the interest of the child should determine what we teach. We overlooked the fact that content is based upon social needs, and that while the interest of a pupil is an important factor in determining the time

and method of presentation, it cannot be a guide in the selection of subject-matter. This attitude with respect to interest led to the practice in the shop of *making things,* to the almost total neglect of actual instruction in the manipulative processes. This was based upon the theory that skill with tools and a knowledge of the best construction methods would be developed incidentally if the pupil is interested in his project. The crude workmanship revealed in the product made under such conditions gave abundant evidence that we got neither skill nor knowledge of good construction. Such a product was sufficient justification for much of the criticism that has been directed at the manual-arts work.

56. Skill Is An Exact Habit. The theory that skill will be developed incidentally violates common sense and the best established laws of psychology. Skill represents an exact and an efficient habit, and we learn to conform to an exact ideal only by conscious and painstaking effort. The theorist assumes that the pupil will discover that he must develop the skill in order to make his prŏduct function. This again, is a theory entirely divorced from facts. An article may function as a table without having in it a single element of what would represent good or skilful workmanship. In trade training definite skills and exact information with respect to the trade are absolutely essential, and the idea of permitting the interest of the pupil to determine what shall be taught is manifestly absurd. The presentation of the things to be taught in a manner that will create the highest possible interest in learning is essential to good methods of teaching.

The solution of the problem lies in a wise combination of the extremes. The list of the things to be taught or learned must have a prominent place as the specific objectives of the course, and the progress of the pupils should be checked against this list. The teacher must realize that it is his job to teach these things. The pupil must realize that it is his job to learn them. This does not mean that they are to be taught or learned as independent or isolated things, but as a part of some worthy undertaking. To be effective, however, the teacher must recognize them as parts of the job, and put forth a conscious and determined effort to teach them. In this way the pupil not only is taught the skills and methods of construction, but he sees them in their practical application.

57. Summary. The first step in teaching is to determine the things you must teach in order to make the individual into what you wish him to be. This involves a definite knowledge of what he is with respect to his ability and accomplishments, and a very exact statement of what you wish him to be. A comparison of these two will give the points in which training will be required. It is obvious that such a list will vary with individuals.

Having determined the things in which the individual should be trained, these things should be analyzed into learning units, suited to the capacity of the individual, and arranged into a convenient form for instruction. Every instruction unit should be examined carefully as to whether it contributes directly to the end sought, and if it does not, it should be rejected for those that do.

QUESTIONS—Chapter IV

1. What means have we for determining native potential abilities?
2. Can we distinguish between native ability and the effect of environment and experience?
3. Upon what basis should we choose the experiences which we will give individuals in training?
4. What factors affect the size of the teaching unit?
5. Why are jobs not satisfactory units of instruction?
6. What principle should guide us in the order of arrangement of the list of things we wish to teach?
7. What items would you strike out of the lists as being relatively unimportant?
8. What items would you add to the lists?
9. Why is it advisable to teach these units through making useful projects?
10. In what respect is interest a factor in teaching?
11. Should a student's interest determine what we teach?

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CHAPTER V

Arranging Our Material

58. Arranging Instruction Material Involves a Number of Factors. Many teachers have made lists of learning units, and have prepared written instructions for them, but have experienced difficulty in arranging a satisfactory scheme for using the material. They have failed to recognize that this is only a part of the preparation necessary in the teaching process, and that, in addition to this, it is necessary to provide a favorable learning situation.

This involves a number of factors: *First,* we must have satisfactory physical surroundings, such as good light, good ventilation, satisfactory temperature, and well arranged equipment, kept in good order. There should be nothing to divert the attention from the things to be learned. *Second,* there must be a definite list of things to be learned. This constitutes a series of specific objectives. The method of preparing such a list is discussed at length in Chapter IV. *Third,* there must be a desire to learn. Without such desire, or readiness, instruction is futile. *Fourth,* we must provide a situation where the individual will feel a responsibility for learning. He must have a definite problem to solve and feel that he is under the necessity of solving it. So long as he feels that it is the teacher's responsibility to teach him, rather than that it is his responsibility to learn, he is likely to take a passive attitude and watch the teacher work. *Fifth,* there must

be available all materials and instructions necessary in solving the problem.

59. Interest in Learning Necessary. Having selected the learning units we propose to teach, whether they belong to a single trade, or consist of some of the elementary things in a great variety of trades, or whether they are scientific principles, mathematical processes, English usage, or general information, it is necessary for us to set up a situation in which the pupil will be interested in learning them. Individuals may be interested in acquiring skill or knowledge if such things are held up to them as worthy accomplishments, and this motive should never be neglected, but the force of it should be supplemented through the presentation of interesting problems which involve the experiences we wish the individuals to get. It is not sufficient, however, to assign interesting jobs or permit the pupil to select jobs which appeal to him. We must be sure that the jobs contain the learning units we wish to teach.

60. How to Select the Jobs. The following plan of selecting shop jobs has been used successfully, and is both simple and effective. It has the merit of being quite flexible, and at the same time providing a well organized group of material covering the entire range of instruction. If the teacher has arranged his list of things he wishes to teach, as indicated in the preceding Chapter, he should select a number of projects which will constitute a list of standard jobs involving these things. It is by no means necessary that the pupils be restricted to this list, but it furnishes a reserve of standard jobs the characteristics and content of which are fully known. The list may be extended indefinitely

as desirable jobs come to the attention of the teacher. The jobs selected should have the following characteristics:

1. *The job should be simple enough to be within the capacity of the boy, yet difficult enough to call forth his ingenuity in planning.* It is a mistake to assign jobs which are so simple that they do not offer a challenge to the skill of the boy or to his resourcefulness in meeting the situation. He must feel that the jobs are worthy of his ability. This is necessary in order that he may have pride in his accomplishment. It is a serious mistake, however, and one which more frequently occurs, to assign a task, or permit him to undertake one, which is beyond his capacity. Such an assignment discourages him, and a teacher is likely to accept a standard of workmanship below that which we should expect.

2. *The job should be such that it can be handled readily under the conditions of the schoolroom.* The limitations of the school shop with respect to tools, materials, and space are such that we are restricted in the choice of jobs by these factors.

3. *The jobs should be well designed.* Never permit or approve the use of a job in the school shop which is not well designed from the standpoint of construction, proportion, utility, and general appearance. The appreciation of these elements is one of the important objectives in this training.

4. *The job must be such that it may be completed in a relatively short period of time.* In general, it is unwise to permit boys to undertake tasks which will extend over long periods. It is very difficult to sustain

interest in one project over weeks or months. The uncompleted projects in most shops testify to the wisdom of this precaution. It is much better to use a number of simple projects involving the things we wish to teach than to undertake a large project which involves the entire group.

5. *In the estimation of the boys the project should have a real use.* The usefulness of a project will be determined to some extent by the conditions of community life. For example, a project which would be useful in a rural high school community might have little value in the high school of a large city, although the project contained the tool processes and construction problems we wish to teach in both situations.

6. *The job must contain some of the elements we wish to teach.* In general, it is desirable that each new job contain new learning units, but after the first few jobs every job selected will contain certain elements in which the student may be proficient. These elements, however, must be repeated in order that he may have an opportunity to get the experience in other skills. The processes thus repeated are those most frequently used, and the opportunity to develop a higher degree of skill in them is desirable. It is not desirable to assign jobs that contain only learning units in which the student has attained the desired degree of proficiency, although it may be expedient at times to do so in order to increase administrative or public interest in the work.

The problems in English, mathematics, science, and drawing must be chosen on the same basis and the same principles applied. They should be selected with

the view of teaching certain specific things in the list. They should be simple enough to be within the capacity of the boys, and difficult enough to call forth his ingenuity and best efforts. He should be able to complete each assignment in a relatively short time, and he should see a real use for the things he is expected to learn.

61. How to Prepare Jobs for Instruction Purposes. Having selected a series of jobs on this basis, the teacher should prepare an accurate drawing and specifications for each job, if drawings are required. There should be no doubt about the suitability of design, construction, material, or finish. Everything should be specified as carefully as it would be for a commercial job. It does not follow that every pupil should be required to do the jobs without modifying the specifications, but if he desires some modification of the design, construction, material, or finish he should make the changes and incorporate them in the drawings and specifications before he begins the task. It is important that the worker know exactly what is required, and that he is expected to do the job as specified, whether he made the design and wrote the specifications, or whether they were prepared by someone else. If, in the progress of the job, conditions arise which make some change necessary, the plans and specifications should be modified. In industrial life the boy will find that he is to do his work according to very strict requirements. Many teachers do not understand that the specifications for a job consist of drawings and written description of the construction, materials, and finish so complete that they might be sent to a work-

man in a distant city and he would produce exactly what is wanted.

When the list of jobs has been prepared, they should be arranged with some respect to the order of difficulty, placing the least difficult ones first. Every job should then be placed on the Analysis-Chart, Fig. 1, and analyzed on the basis of the things we wish to teach. This will enable us to determine what instructions will be required and what experiences will be obtained in doing each job.

62. Information Units Need Not Be Placed on Analysis-Chart. It is not necessary to place on the Analysis-Chart the learning units dealing with information or the so-called related-subject material. Such learning units should be kept as a separate list, from which units may be selected and assigned in connection with any job in which conditions are favorable for learning them. A great deal of this material may be taught in connection with one job as well as another, and its assignment to a particular job is merely a matter of convenience. They should be listed on a Progress-Chart, so that students may be given credit when they have passed a satisfactory test in any of them. If these learning units are carefully selected, and the presentation well planned, a surprising interest may be created in establishing proficiency in them. For example, contests in identifying samples of wood, sizes of screws or nails, gages of metal or wire, size or style of type, and so on, will develop a great deal of interest in such things, and the boy will accept the responsibility for learning them. A certain percentage may be required for proficiency, but above that he has the incentive of

LEARNING UNITS INVOLVED IN THESE JOBS	JOBS: 1 CUTTING BOARD	2 TEA POT STAND	3 CALENDAR RACK	4 SWING BOARD	5 GAME BOARD	6 CARD RACK	7 RABBIT TRAP	8 TIE RACK	9 CANDLE STICK	10 BIRD HOUSE	PLANT STAND	FOOT STOO	NAIL AND	UPHO
1 HOW TO READ A WORKING DRAWING	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2 HOW TO MAKE A BILL OF MATERIAL	●	●	●	●	●	●	●	●	●	●	●	●	●	●
3 HOW TO PLAN YOUR PROCEDURE	●	●	●	●	●	●	●	●	●	●	●	●	●	●
4 HOW TO CHECK MATERIAL WHEN RECEIVED	●	●	●	●	●	●	●	●	●	●	●	●	●	●
5 HOW TO MEASURE AND DIVIDE SPACES WITH A RULE	●	●	●	●	●	●	●	●	●	●	●	●	●	●
6 HOW TO USE PENCIL OR KNIFE IN LAYING OUT WORK	●	●	●	●	●	●	●	●	●	●	●	●	●	●
7 HOW TO USE DIVIDERS FOR CURVES AND FOR DIVIDING SPACES					●	●	●	●	●	●	●		●	●
8 HOW TO GAGE WITH A MARKING GAGE OR RULE	●	●	●	●	●	●	●	●	●	●	●	●	●	●
9 HOW TO USE THE TRY-SQUARE IN LAYING OUT SQUARE CUTS & TESTING	●	●	●	●	●	●	●	●	●	●	●	●	●	●
10 HOW TO ADJUST A PLANE	●	●	●	●	●	●	●	●	●	●	●	●	●	●
11 HOW TO PLANE A SURFACE TRUE	●	●	●	●	●	●	●	●	●	●	●	●	●	●
12 HOW TO PLANE END GRAIN	●	●	●	●	●		●	●	●	●	●	●	●	●
13 HOW TO SQUARE A BOARD	●	●	●	●	●	●	●	●	●	●	●	●	●	●

FIG. 1. Section of a form suggested for an Analysis-Chart for Woodworking.

a comparative rating with the other members of the group.

Such a chart is a great convenience for the teacher. It not only gives him a graphic picture of the instruction units involved in every standard job listed; but he can, and should, analyze every job that comes to the shop, and place it on his analysis-chart before it is approved for production. In that way he can determine whether the job contains the elements he wishes to teach. When this analysis is considered in connection with the Progress-Chart, it is easy to determine to whom a task should be assigned or whether

it may be undertaken with profit by any member of the class. It also gives the teacher a means of protecting his class against the imposition of penurious administrative authorities who often look upon the shop as merely a place where repair work can be done cheaply, or where articles may be produced for the school at a cost below current prices.

Many teachers and pupils are imposed upon because the teacher does not have a definite list of the things he wishes to teach, and when a job is sent to the shop he is unable to check it and determine its value. He cannot refuse it on the basis that it does not contain the things he wishes to teach at that time, because he has no list of such things. If the teacher had an analysis or a list of the things he wishes to teach, and a record of the proficiency of each student in these things, he could readily analyze any job sent to the shop, and assign it to the students that need that kind of work; or, he could reject it, and show to the authorities his justification for doing so. This would relieve the shop of much of the productive work which does not give the kind of experience and training needed.

The use of practical jobs does not preclude the use of a fixed series of jobs which form the core of the course of instruction around which the production jobs are grouped. The specially selected series of jobs should involve the operations which the student must learn if he has no opportunity to learn them in production jobs. Practice is necessary in order to develop skill, and it is folly to suppose that any school will be so advantageously situated that, for any considerable length of time, it can supply production jobs in sufficient quantity and variety and with suitable distribution of the elements in which the student must be trained, to meet all the requirements of instruction. Men work in a trade for years without an opportunity to get experience in more than a fraction of the field. The trade school must give a broader training even if it must do it by practice work. In any phase of habit formation or learned relations repetition is necessary, and we cannot depend upon the incidental repetition of occasional jobs to establish an exact habit. The chief reason why it takes the apprentice so long to learn his trade is that he has no opportunity for systematic practice or instruction in the things he needs to know. When a problem arises he makes a guess or uses some crude device to

approximate the result and goes on, seeking to avoid situations where such requirements arise.[1]

63. Production Work and Practice Work. During recent years a great deal of emphasis has been placed upon production work in school shops. The purpose has been to correct a rather serious situation that had grown up as a result of the formalism in shopwork. However, it has been emphasized to such an extent that in some cases its real purpose has been lost sight of, and there is a danger that it will produce a situation that is as serious as the one it is designed to correct.

In view of the situation it is well to examine both sides of the question. We must keep in mind the fact that the primary purpose of the school is to give instruction, and that the shopwork is used as a means to that end. Therefore, the value of any work must be determined by the degree to which it contributes to this purpose. A piece of production work may be valuable for instruction purposes, or it may not. If it does not contain the elements we wish to teach, it is not as valuable as the piece of practice work that does contain those elements. In either case it is necessary to check it against our list of learning units, for that is the only means by which we can measure the value of any kind of work as a means of teaching.

Practice work consists of a selected series of tasks or jobs which have been selected primarily because they offer the opportunity to develop the skills required, and are convenient for use in the school, are

[1] R. W. Selvidge, *Individual Instruction Sheets,* The Manual Arts Press, Peoria, Illinois, 1926.

interesting, and have some personal or commercial value. The practice work that has been condemned consisted largely of exercises in skills entirely separated from their application to a useful product. A product may be useful and yet not produced on a commercial scale. Such a product may have a very distinct learning value, but it does not carry with it the spirit of modern commercial or industrial life.

Production work is highly desirable if we can secure the kind of production jobs that contain the learning units we wish to teach and that will give practice in these units in the required proportion. This can be determined easily by a careful analysis of all available production jobs.

Probably the best plan is to use a combination of the two. The teacher should prepare a list of standard jobs, involving all of the units of instruction, so selected as to give sufficient practice in each unit. He should also seek production work from the outside. The production jobs should be analyzed in order to determine the extent to which they offer opportunities to teach the things we wish to teach, and they should then be supplemented by the standard jobs he has selected.

64. Let the Student Know What He Is Expected to Learn On a Job. One of the most fundamental things in good teaching is the definite and proper assignment of the lesson or task. The pupil is entitled to know what he is expected to learn. He is given a job to do, not because we want something made, but because we want him to learn certain things, and he will have an opportunity to learn them in doing this job. If we

have analyzed the job for the learning units, it is a simple matter to take from the Analysis-Chart a list of the learning units involved. If this list of learning units is attached to the job drawings and specifications when it is assigned, the pupil will know what he is expected to learn as well as what he is expected to do, and he will be pleased to discover that in addition to doing an interesting job he has an opportunity to learn certain things. If, in addition, he knows that he will be tested on whether he has learned them or not, and will receive definite credit if he has, a very favorable learning situation is created. In order to carry out this idea there should be placed on the back of each blueprint or attached to each job specification a statement somewhat as follows:

LEARNING UNITS OF THIS JOB

"In doing this job you will have an opportunity to learn the new things in the following list, and to acquire additional skill in the old ones:

(Here list the learning units that have been checked on the Analysis-Chart. This will include the skills involved in the job, and any items of information you may wish to teach in connection with this particular job.

It is not necessary to list all the elementary learning units if it is an advanced job. If the analysis shows that it contains learning units of such a difficult character that it would not be assigned to students who have not acquired proficiency in the more elementary processes, it is unnecessary to list the more elementary learning units.)

"When the job is finished you will be tested on any new items appearing in the list. Be sure you know them before turning in your work.

"When you have shown proficiency in any unit you will be given credit on the Progress-Chart."

In the beginning the student may tend to rely too much on this list of learning units in making his job plan, as the two will be almost identical in the first simple jobs, but he will discover as his work progresses that a step in the job plan may include several of the elementary learning units, and that the sequence in the list of learning units is not the same as the sequence of the steps in doing the job. He must get the distinction that the learning units are what he must learn, and that the job plan is a list of the major steps he will take in doing the job.

65. The Job Plan. The next step is to prepare a job plan for each job. This is simply a list of the principal steps to be taken in doing the job and they should be listed in the order in which they will be done. This plan is for the teacher's use, and represents what he regards as the best method of procedure in doing the job. The pupil will be required to make his own plan when the job is assigned to him.

The drawings and specifications, the list of instruction units involved in each job, and the plan for doing the job, should be filed together for future use. Other projects should be handled in the same manner. Those involving the same units of instruction should be grouped together. This gives a maximum of flexibility, as a great variety of projects may be placed within a group. Projects should be selected and analyzed until every instruction unit in the list is provided for. New jobs should be added as worthy ones come to the attention of the teacher. A student may suggest a new job or modify one already in the list, but no job should be approved until the drawings and specifications are

complete and it is analyzed on the Analysis-Chart and the instruction units listed.

66. Examples of Organized Instruction Material. The following examples show how the material for each job should be organized. If the teacher has a supply of standard jobs organized in this manner he is always ready to assign a new job without delay, and no boy is ever idle for want of something to do. Every new job should be prepared in the same way before the boys start to work on it. Never be rushed into starting a job before this is done.

Job Number 1

CUTTING-BOARD

SPECIFICATIONS

To be made of sugar pine, sanded smooth, and the edges enameled a color to be chosen by the maker and approved by the teacher. See Fig. 2.

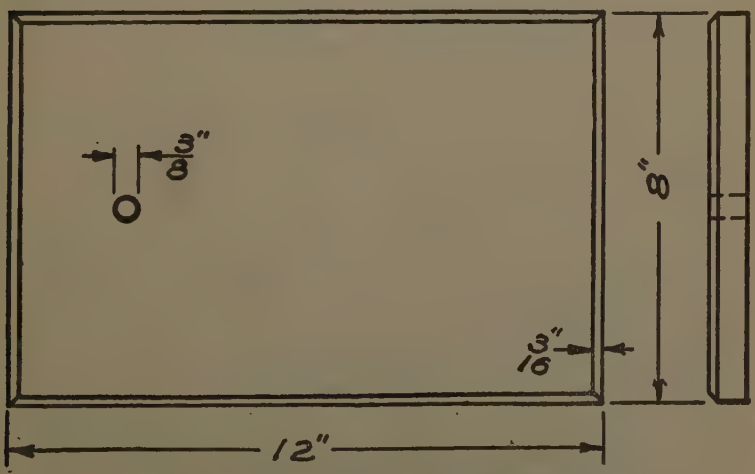

FIG. 2. Working-drawing of the Cutting-Board.

It generally is advisable to have the specifications on a separate sheet from the drawing as the specifications are more likely to change than the drawings. Any change in material or finish involves a change in the specifications.

LEARNING UNITS OF THIS JOB

(*Note:*—To be placed on back of drawing, or attached to specifications.)

In doing this job you will have an opportunity to learn the following things:

How to read a drawing.
How to make out a bill of material.
How to plan the procedure in doing the job.
How to check material when received.
How to measure with a rule.
How to use a pencil in laying out work.
How to gage with a pencil.
How to use a try-square for laying out work and testing.
How to adjust a plane.
How to plane a surface true.
How to plane end grain.
How to square up a board.
How to sandpaper.
How to bore holes with auger-bit.
How to lay out and plane a chamfer.
How to apply enamel.
How to care for enamel-brushes.

When the job is finished you will be tested on the items appearing on this list. Be sure you know them before turning in your work. When you have shown proficiency in any of these you will receive credit on the Progress-Chart.

This appears to be a formidable list, but it is only a list of the things involved in this job which the boy would have an opportunity to learn. Few teachers realize that there are so many learning units for the

beginner in such a simple task. Such a list reveals what he must teach as well as what the boy has an opportunity to learn. Surely there is some advantage both to the teacher and the learner in having the specific objectives set forth in such a definite way.

One of our chief sources of difficulty in teaching is that the boy sets out to make something and neither he nor the teacher realize how much and what he has to learn in order to do it.

It will be observed that while the list of learning units will offer some suggestions to one making a job plan, the order of arrangement of the learning units is not the same as the steps in the job plan, and one of the steps in the job plan may contain two or more of the learning units.

JOB PLAN

Order of Procedure:

1. Make out bill of material.
2. Get material and check it.
3. Square board to size.
4. Lay out chamfer.
5. Locate point where hole is to be bored.
6. Plane chamfer.
7. Bore hole.
8. Sandpaper.
9. Enamel edges.
10. Clean brush.

It is probable that the teacher would wish to check the boy's work at certain points during his progress, and he should put a check mark on the boy's plan at these points. For example, he probably would wish to check the work when step three is finished, again after step five, and possibly after each succeeding step;

and, if so, he should place a check mark at these points.

It will be necessary to check more frequently in beginning work than later, and it will be necessary to check some individuals at shorter intervals than others.

TESTS

1. Examine board for dimensions, accuracy of tool work, and finish.
2. What is the order of procedure in squaring up the board?
3. What precautions are necessary in planing end grain.
4. How is the size of an auger-bit indicated?
5. What precautions are necessary in boring a hole through a board?
6. What precautions are necessary in sandpapering?
7. Why is it necessary to clean the enamel from the brush? What material did you use for cleaning it?

Job Number 5

THE WREN-HOUSE

SPECIFICATIONS

To be made of cypress and stained brown. See Fig. 3.

LEARNING UNITS IN THIS JOB

In making this wren-house you will have an opportunity to learn the new things in this list, and to acquire additional skill in the old ones:

1. How to read a working-drawing.
2. How to make out a bill of material.
3. How to plan the procedure in doing the job.
4. How to check your material when received.
5. How to measure with a rule.
6. How to use a pencil in laying out work.
7. How to use a try-square for laying out square cuts and testing.
10. How to adjust a plane.
11. How to plane a surface true.
12. How to plane end grain.
13. How to square up a board.
14. How to lay out pattern on stock.

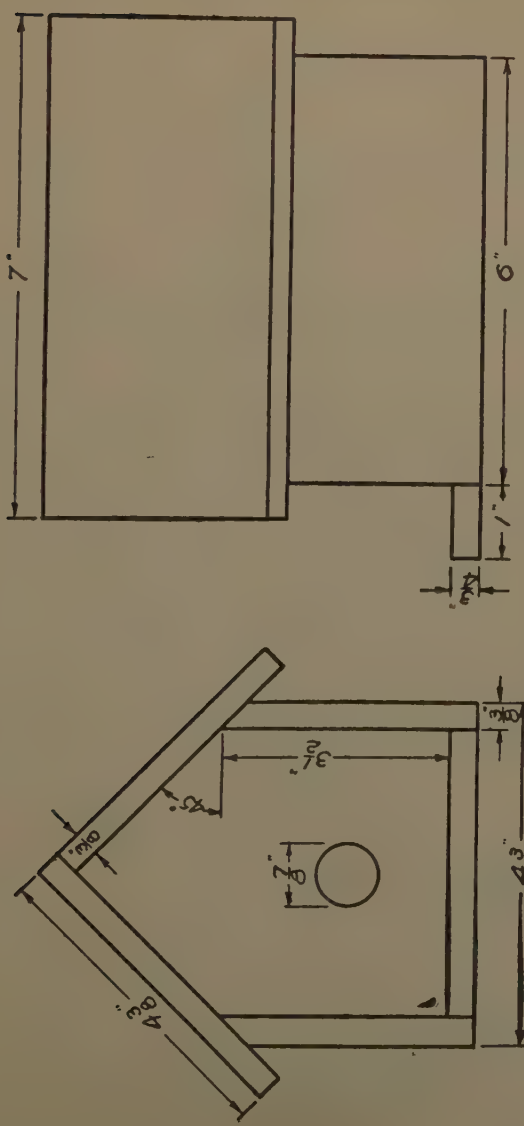

FIG. 3. Working-drawing of the Wren-House.

15. How to saw to a line.
24. How to drive nails.
27. How to bore holes with an auger-bit.
28. How to use a T-bevel.
29. How to lay out and plane a chamfer or bevel.
32. How to apply stain.
33. How to clean and care for stain brushes.

THINGS YOU SHOULD KNOW

Concerning lumber:

1. The qualities, working characteristics, and source of cypress.
6. The nominal dimensions and the actual dimensions of stock lumber.

When the job is finished you will be tested on any items for which you have not received credit, and any new items appearing in the list. Be sure you know them before turning in your completed job. When you have shown proficiency in any item you will be given credit on the Progress-Chart.

It will be observed that we have attached to this list of learning units two items of information. These items are not essential to success in doing the job, but they are things we wish the boy to know, and they may be attached to this job as well as any other. We should be careful not to attach too many such units to any one job.

JOB PLAN

Procedure:

1. Make out bill of material.
2. Get material and check it.
3. Square all pieces to exact size.
4. Lay out ends and sides.
5. Cut ends to shape.
6. Bore hole in end piece.
7. Bevel side pieces.
8. Nail bottom to end pieces.
9. Nail sides to end pieces and bottom.
10. Nail on top, nailing narrow piece on first.

TESTS

1. Test work for dimensions and accuracy of tool work.
2. What kind of saw did you use?
3. How did you start the saw?
4. What precautions are necessary in nailing?
5. What precautions are necessary in boring holes in thin boards to prevent splitting?
6. How do you set and use the T-bevel?
7. How does a stain differ from an enamel or paint?
8. In what part of the country does cypress grow? What are its most outstanding qualities?
9. What are the actual thickness and width of a finished 2x4? What are the actual dimensions of a finished 1x8x10? Of a 1x10x10?

Job. No. 8

PLANT-STAND

SPECIFICATIONS

To be made of plain white oak, stained with a fumed oak stain, filled and finished with two coats of flat varnish, sanded lightly between coats. See Fig. 4.

LEARNING UNITS IN THIS JOB

In making this plant-stand you will have opportunity to learn the new things in the following list, and to acquire additional skill in the old ones:

1. How to read a working-drawing.
2. How to make out a bill of material.
3. How to plan the procedure in doing the job.
4. How to check material when received.
5. How to measure with a rule.
6. How to use a pencil in laying out work.
7. How to divide or use compasses in laying out curves.
9. How to use a try-square in laying out and testing.
10. How to adjust a plane.
11. How to plane a surface true.
12. How to plane end grain.
13. How to square up a board.
14. How to lay out pattern on stock.
15. How to saw to a line.
17. How to finish outside curves.

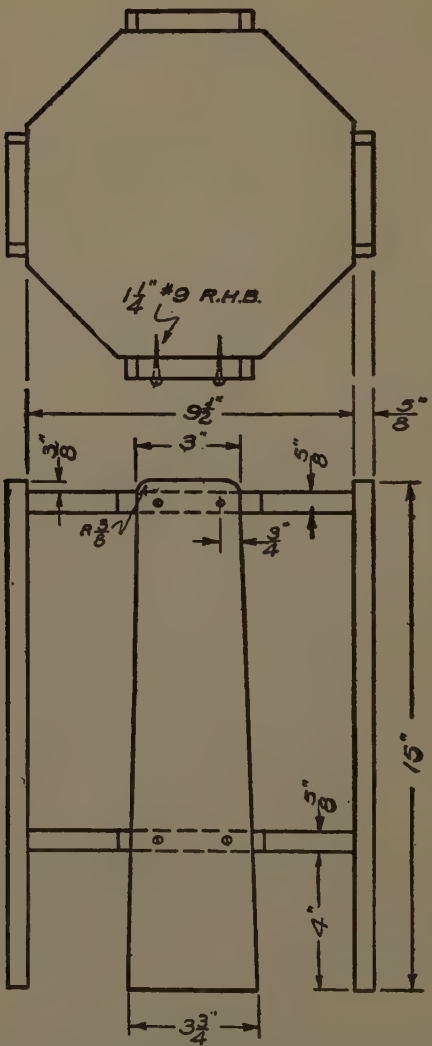

FIG. 4. Working-drawing of the Plant-Stand.

19. How to drill holes in wood.
21. How to trim with chisel.
22. How to use sandpaper properly.
23. How to fasten with screws.
26. How to use a scraper.
29. How to use a T-bevel.
32. How to apply stain.
33. How to clean and care for stain-brushes.
35. How to apply filler.
39. How to apply varnish.
40. How to clean and care for varnish brushes.

THINGS YOU SHOULD KNOW

Concerning lumber:

1. Be able to identify white oak.
2. Its working qualities, where it grows, and its principal uses.

Concerning screws:

1. The kinds of screws.
2. The uses of the different kinds.
3. How the sizes of screws are indicated.
4. How they are sold.

When the job is finished you will be tested on any items for which you have not received credit, and any new items appearing in the list. Be sure you know them before submitting your completed job. When you have shown proficiency in any item you will be given credit on the Progress-Chart.

JOB PLAN

Procedure:

1. Make out bill of material.
2. Get material and check it.
3. Square all pieces to dimensions.
4. Lay out top and shelf, and check layout by comparing the pieces.
5. Lay out legs, including rounded corners, locations of the top and shelf on the legs, and the screw holes, and check the layout on all the legs.
6. Plane the taper on the legs.
7. Round the corners with chisel.
8. Drill holes in legs for screws.

9. Saw corners off on top and shelf.
10. Finish both pieces to same size with plane.
11. Scrape and sand.
12. Locate and drill holes for screws in top and shelf.
13. Assemble by fastening legs to shelf with screws, and then fastening in top.
14. Stain and sand lightly after it is dry.
15. Apply filler.
16. Apply first coat of varnish.
17. After three days, sand, and apply second coat of varnish.

TESTS

1. Test work for dimensions, accuracy, and finish.
2. What is the method of procedure in laying out tapered work like the legs of this stand?
3. What is the advantage of laying out all points and lines before the taper is cut?
4. In what direction is the cut made in trimming the corners with a chisel?
5. How large should the holes for the screws be as compared with the screw?
6. What effect did the stain have on the grain of the wood?
7. What is the purpose of the filler?
8. Is a No. 8 screw larger than a No. 12?
9. Do all No. 10 screws have the same diameter, or does the diameter vary with the length of the screw?

SHEET-METALWORK

Job Number 5

TIN CUP

SPECIFICATIONS

To be made of I-C bright tin according to pattern furnished. To have handle, and the top to be wired with No. 14 wire. To have locked seam on side and double seam bottom. See Fig. 5.

LEARNING UNITS IN THIS JOB

In making this cup you will have an opportunity to learn the new things in the following list, and to acquire additional skill in the old ones:

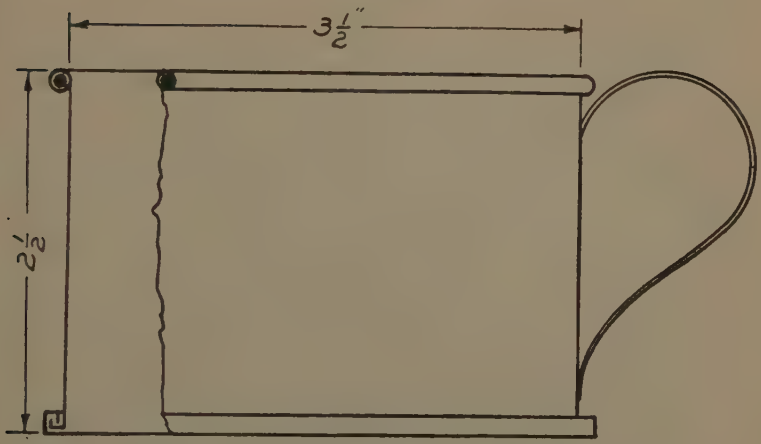

FIG. 5. Working-drawing of the Tin Cup.

1. How to plan the procedure for doing the job.
2. How to make out a bill of material.
3. How to transfer patterns to sheet-metal.
5. How to use snips in cutting metal.
6. How to solder tin.
7. How to light and operate a blow-torch or gas-furnace.
8. How to use the squaring-shears.
9. How to use the bar-folder.
10. How to turn edges for hem.
15. How to roll a sheet on a forming-machine.
16. How to wire edges.
17. How to turn lock seams.
18. How to groove with hand-groover.
19. How to use a burring-machine.
20. How to make a setting-down seam.
21. How to make a double seam.

WHAT YOU SHOULD KNOW

1. The weights and grades of tin plate.
2. Kinds of flux used in soldering different kinds of metal.

When the job is finished you will be tested on any items for which you have not received credit and any new items appearing in the list. Be sure you know them before submitting your finished job. When you have shown a proficiency in any of them you will be given credit on the Progress-Chart.

JOB PLAN

Procedure:

1. Make out bill of material.
2. Get material and check it for size.
3. Lay out pattern for side and handle on stock.
4. Cut to required size on squaring-shears.
5. Notch corners of blank for wire and seam with snips.
6. Turn lock on ends of side piece on folding-machine.
7. Turn round edge for wire.
8. Put in wire on wiring-machine, allowing it to project ½″ at one end.
9. Form on the forming-machine, having wire on outside.
10. Lock the ends together and groove with hand-groover.
11. Pound down seam with mallet, and solder on inside.
12. Turn burr on bottom edge with burring-machine.
13. Cut out the bottom.
14. Turn a burr on the bottom with the burring-machine.
15. Slip the bottom on the body, and set down the seam on the setting-down machine.
16. Double-seam the bottom with the double-seaming machine.
17. Solder the bottom on the inside of the cup.
18. Double-hem edges of handle.
19. Form handle to shape.
20. Solder handle on cup at the side seam.

TESTS

1. Why must the folds for a lock seam be turned in opposite directions?
2. Why should the top be wired before the cup is formed?
3. Why is the wire allowed to project about ½″ from one side when wiring the top?
4. What flux did you use in soldering?
5. What kind of solder did you use?

67. Instruction Material in All Subjects Should Be Organized. Jobs in all the subjects to be taught should be selected and the material arranged in this manner, and there should be a sufficient number of such jobs containing the same learning units to afford variety. Any new job should be arranged in the same manner.

This is simply the teacher's preparation of his instruction material. It is expected that the academic teacher will spend some time each day in the preparation of his lessons, and if he is a good teacher he would not attempt to present new material without first preparing it. The shop teacher should have his standard jobs prepared, and it certainly will require no more of his time to prepare the new jobs for teaching purposes than is required of the academic teacher for his preparation.

68. The Progress-Chart. In order to carry out this plan of instruction a Progress-Chart should be provided, on which the pupils' names are arranged in a vertical column at the left side of the chart, and the list of learning units in a horizontal column at the top of the chart, so that each pupil may be given credit as soon as he has attained proficiency in any item. See Fig. 6. If the arrangement is more convenient the position of the lists on the chart may be reversed. This chart should be posted in the classroom in order that the record of any student may be publicly known. A public record of accomplishment is the greatest foe of indolence and indifference.

Provision should be made for three ratings on each item on the chart. Some mark should be used to indicate the first experience in the item; another mark to indicate a fair proficiency in the item; a third should indicate that the pupil has attained the required proficiency. When a pupil has received this mark it will not be necessary to provide jobs to give additional practice in this item, but many jobs may give practice incidentally.

NAMES	1 HOW TO READ A WORKING DRAWING	2 HOW TO MAKE A BILL OF MATERIAL	3 HOW TO PLAN A PROCEDURE FOR A JOB	4 HOW TO CHECK MATERIAL WHEN RECEIVED	5 HOW TO MEASURE AND DIVIDE SPACES WITH A RULE	6 HOW TO USE PENCIL OR KNIFE FOR LAYING OUT WORK	7 HOW TO USE DIVIDERS OR COMPASS FOR LAYING OUT CURVES & DIVIDING SPACES	8 HOW TO GAGE WITH A MARKING GAGE OR RULE	9 HOW TO USE THE TRY-SQUARE FOR LAYING OUT	10 HOW TO ADJUST	11 HOW TO PLANE	12 HOW	13
1 ALT, RICHARD	1	1	1/2	1	1	1/2	1	1	1				
2 AMES, HARRY	2/3	2	1/2	2/3	1/2	2		1	1	1	1/2		
3 BELL, BILLY	1	1	1	1/2	2/3	2	1	1/2	2		1	1	
4 BLACK, JAMES	2	2	1	1/2/3	1/2	1/2	1	1/2/3	1/2	1	1	1	1
5 BREWSTER, STANLEY	1/2	1/2	1/2	2	2	1/2		1/2	2	1	1	1	1
6 CAYAWOOD, BOB	1/2/3	1/2/3	1/2/3	1/2/3	1/2/3	1/2	1	1/2	2		2	1	1
7 DEAN, THOMAS	2	1	1	2	1/2	2	1	2	1	1/2	1	1	1
8 EDWARDS, GEO	1	1	1	1/2	1	1	1	1	1				
9 FORST, EDDY	1/2	2	2	1/2	1/2	1	1/2	1	2	1	2	1	1
10 GOGGINS, DON	1	1	1	1/2	1	1	1	1	1	1			
11 GRAHAM, CHAS	1/2/3	1/2	1/2	1/2/3	1/2	2	1	1/2	2	1/2	1/2	1	1
12 HOUSE, KENNETH	1	1	1	1	1	1	1	1	1	1			
13 HOPPE, JOHN	1/2	2	2	1/2	1/2	1	1/2	1	2	1	2	1	1

FIG. 6. Section of a form suggested for a Progress-Chart.

There should be a similar Progress-Chart for the learning units of information or related subjects. On such a chart a single rating will be sufficient, as the learning of those things is not a progressive matter to the same degree that the learning of skills is.

Teachers are inclined to neglect keeping the Progress-Chart, but the statement on the list of learning units that credit will be given on the chart when proficiency is shown will encourage the boy to insist upon his credit.

69. The Training Certificate. The Progress-Chart is of great value in trade work, as it furnishes a record showing the portion of the trade in which the boy is proficient. If he leaves before the completion of his training he may be given a certificate containing a list of the learning units checked in such a way as to show the ones in which he has made a satisfactory record. This certificate will be of value to him in securing employment, as it shows what he can do; it will be of value to the employer, as it will enable him to assign the boy tasks within the range of his training; it will be of value to the school, because it certifies the competency of the boy in particular things and assumes no responsibility for the others. The reputations of schools have suffered because employers have not known in what things the pupils were trained, and the boys have sometimes given a wrong impression in order to get a job.

Such a chart eliminates the time element as a measure of training. A boy may complete the training units as rapidly as possible, and when he has attained the required proficiency in them he has finished his training in the school, whether it has taken him six months or six years. It is evident that, on account of differences in individual ability, some individuals will require at least a third more time to attain a given degree of proficiency in the learning units than will be required for others. It is equally evident that it requires much more time to learn certain trades than it does to learn others.[2]

It probably is not desirable for the trade schools to

[2] R. W. Selvidge, *How to Teach a Trade,* Manual Arts Press.

abolish the annual commencement exercises and the granting of diplomas, as these features afford public recognition of accomplishment, and the spectacular element in them appeals to many people, but there is no reason why the work may not be completed at any time during the year, and the diploma given at the annual commencement. The diploma, however, should not take the place of the certificate showing the learning units in which the boy is proficient.

70. Testing. We should have a definite plan for testing the proficiency of pupils in each learning unit. These tests need not be standardized, but there is no objection to standardized tests if they are available and offer a satisfactory means of testing the things you wish to test. The test should be simple, short, and of such a character that the pupil feels that it is only a means of proving to the teacher that he knows the thing he set out to learn. If the pupil knows he is expected to learn certain things in connection with a task, and knows that he will receive credit for his accomplishment, he is just as eager to take his test and get his rating as the Boy Scout is. The test may consist of an examination of the boy's work, oral questioning, written reports, oral reports to a group, or any other means offering the boy an opportunity to show that he is proficient in the particular learning unit in which he is being tested. He should understand that he will never receive a proficiency mark until he passes his test.

71. Plan Applies to Production Work. It may be urged that while this plan will work for a selected list of standard jobs, it will not do where production

work is involved. It is true that rush jobs often are sent to the school shop with very indefinite drawings and specifications, with the request that the work must be pushed through to completion. This is often likely to be true of jobs for the school, and we must examine the situation carefully to see how such jobs can be handled. In the first place, the teacher should have enough poise to avoid being rushed except on rare occasions when an emergency arises. There should be no unnecessary delay, or lack of interest in trying to meet these requirements, but enough time must be taken to do the job properly. Nothing is gained by rushing around excitedly because somebody else is in a hurry.

If a job is requested, and adequate drawings and specifications are not furnished, they should be asked for. In many cases the shop teacher is expected to supply these. In that case he should make the necessary drawings and specifications and have them approved. He should then place the job on the Analysis-Chart, and analyze it for the learning units it contains. This is quickly done, and it is the only way of discovering definitely whether it is a desirable job for teaching purposes, and to whom it should be assigned, if it is. Often it may be expedient to do jobs that have no particular learning value for the class at that time, but it is well to have an analysis so everyone will understand the situation.

When the job is analyzed, a list of the learning units should be made and attached to the drawings and specifications, in order that the pupils may know what they are expected to learn. This list is taken from the

Analysis-Chart. The teacher should then plan the job, listing the principal steps of the job in their order. The drawings and specifications and the list of learning units are now ready to submit to the one who is to do the job. The job plan made by the teacher should be retained by him as a basis for checking the plans of the students.

Although this may appear to involve a great deal of time for a production job, it is only what we ordinarily do in a rather informal, indefinite, and ineffective way. To do it in a formal and definite way will save time and material. It is a distinct advantage to know exactly what is required in the job before starting on it. Definite specifications is one of the elements of production work, and unless we know the requirements of a job we have no means of knowing whether the product will meet the approval of those for whom it is produced. It is, therefore, the best practice to secure, or carefully to prepare, the specifications for a job, and such drawings as are necessary, before beginning the work.

An analysis of the job is especially important, if it is to be used for instruction purposes, in order that we may know what we are teaching, and in order that we may have a record of the experiences of the students. This analysis may be quickly made by placing the job on the Analysis-Chart and checking the learning units involved.

In taking the list of the learning units from the Analysis-Chart to attach to the job specifications it is not necessary to list all the elementary learning units if it is an advanced job. When the analysis of a job

shows that it contains learning units of such an advanced character that it would not be assigned to students who have not attained proficiency in the more elementary processes, it is unnecessary to list the elementary learning units.

The student should always have a definite plan of procedure before starting on a job. In order to emphasize the importance of this it is well to have him make a written list of the principal steps in doing the job. This will call attention to the necessary preliminary steps, and give some understanding of the advantage of orderly procedure.

For example, if the job is "To Lay Bricks to a Line," the job plan might be somewhat as follows:

(1) See that the line is properly set.
(2) Clear all unnecessary material from the working space.
(3) See that the mortar-board is in the proper position with the required kind of mortar.
(4) See that there is a supply of bricks conveniently arranged for laying.
(5) Begin at the left, and lay to the right.

A number of conditions might alter the steps in such a job plan, but the advantage of having a beginner state definitely the steps he will take in doing a job must be obvious. It gives him a definite program of work and gives the teacher an opportunity to give assistance where it is needed.

In the case of repair jobs it is sometimes very difficult to make the analysis of the job and a plan for doing it before starting with the work, as it may be impossible to determine the extent or character of the repair needed before making an investigation which may involve considerable work. In such cases there

are two distinct phases of the job. The first is to determine what repairs are required, and the second is to make the repairs. This may well involve two plans: one, the procedure in determining the character of the repairs needed; and the other, which must come later, giving the procedure for making the repair.

72. Summary. In organizing our instruction material for teaching purposes we must have:

1. A list of the learning units, or things to be taught.

2. A list of standard jobs, projects, or assignments to be used in teaching these units. In the selection of these the following rules should be observed:

(a) The job should be simple enough to be within the capacity of the boy, yet difficult enough to call forth his ingenuity in planning.

(b) The job should be such that it can be handled readily under the conditions of the schoolroom.

(c) The job should be well designed.

(d) The job should be such that it may be completed in a relatively short period of time.

(e) In the estimate of the boys the project should have a real use.

(f) The job must contain some of the elements we wish to teach.

3. There should be very exact specifications, including drawings or blueprints for each job. These should be so clear and definite that a workman in a distant city could follow them and produce exactly what is required. If blueprints are used, it is best to have the specifications on separate sheets, as they are more likely to change than the design of the problem.

4. Each job should be placed on the Analysis-Chart and analyzed for the teaching units involved. This should be done with each new job, as well as with the standard jobs.

5. On the back of each blueprint or specification should be a list of the teaching units involved in the job. This list should be taken from the Analysis-Chart, and may contain any item of information you wish to present in connection with this job, although the item might have an equally close connection with other jobs.

This list should be preceded by a statement somewhat as follows. "In doing this job you will have an opportunity to learn the new things in the following list, and to acquire additional skill in the old ones."

6. There should be a plan of procedure for each job. This should be a list of the steps one would take in doing the job, and they should be listed in the order in which they will be taken. This list will not be identical with the list of teaching units on the back of the drawing. One step in the plan of an advanced job might include several of the elementary teaching units.

7. There should be a Progress-Chart on which is recorded the progress of each individual in learning the items of the list.

73. Observation Problem.

Assignment: Go to the classroom, and observe the general physical conditions, the arrangement of instruction material, the interest and the attitude of pupils. As a result of your observations you should be able to answer the following questions in your written report. Arrange to interview the teacher at some other time on any points that are not clear to you.

1. Were the ventilation and temperature of the room satisfactory?

2. Was the room in order and well arranged? Make suggestions for any improvement you think desirable.

3. Was there any chart or any other means employed to let the pupils know what they were expected to learn?

4. What was the plan for selecting and assigning the jobs? Was the plan satisfactory? Why?

5. How did the teacher determine the learning units in the jobs? Did the pupils know what they were?

6. Was there any device for recording the progress of students?

7. Did students know their standing?

8. Were the jobs production jobs?

9. What was the general attitude of the students? What appeared to be the reason for this?

QUESTIONS—Chapter V

1. Why is a list of standard jobs desirable?
2. What are the necessary steps in preparing a job for instruction purposes?
3. What elements must be considered in selecting jobs?
4. Do the same principles apply in the selection of production jobs?
5. What is a production job?
6. What advantages are there in keeping a Progress-Chart?
7. What advantage is there in giving the student a list of the things he will have an opportunity to learn in doing the job?
8. Why is it unnecessary to place the learning units dealing with information and related subjects on the Analysis-Chart? What will determine when this material will be presented?
9. Why are drawings and specifications necessary?
10. What is the advantage of a definite job plan?

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CHAPTER VI

The Preparation of Instructions

74. Factors to Be Considered in the Preparation of Instructions. Having discussed the problem of the selection and arrangement of the things we wish to teach, we now consider the preparation of the instructions for each teaching unit. In doing this it is necessary to take into consideration three fundamental factors: *First,* learning is an individual process, whether the individuals are assembled together in a group, all trying to learn the same thing at the same time, or whether they are singly trying to learn different things at the same time. *Second,* there is a wide range in the learning abilities of the members of a group in any particular situation due to differences in intelligence, training, attitudes, and other factors. Careful investigation has shown that these differences are much greater than is generally supposed. *Third,* adequate provision should be made for instruction which will permit and encourage learning progress according to the ability of the individual.

75. We Must Provide for Individual Progress. As a profession we are confronted with the task of devising a scheme which will provide for individual instruction and individual progress, or we must acknowledge that we are incapable of meeting the manifest requirements revealed by scientific investigation. The plan must provide for adequate instruction, permit individual progress without respect to the remainder of the group, make the individual conscious of his responsi-

bility for learning, and at the same time be within the range of reasonable cost. To meet these conditions the instructions must be adequate and easily understood, and they must be available to the student when he needs them. We cannot rightly hold the individual responsible unless we make available adequate means for meeting his responsibility. He must not be compelled to wait for his instructions until the other members of the class need them, nor must he be required to take them before he is ready for them. If he is required to wait for instructions he is likely to develop habits of indolence and carelessness. If he is required to take instructions before he is ready for them it is difficult to secure his active interest, and he is likely to forget them before he has an opportunity to use them.

It is obvious that group instruction cannot meet these requirements. In view of our present knowledge, if we depend upon group instruction we must do it with the full understanding that it is retarding the more intelligent individuals, and establishing habits of indolence, while those who are less intelligent are being carried through a maze in which they find it impossible to orient themselves.

76. Grouping Not a Remedy for Difficulties Arising from Individual Differences. We have resorted to many ingenious devices in the way of grouping and grading, and in this way we have narrowed the range of abilities in a given group; but this plan is not always feasible, and in the most carefully selected groups the time required for learning a given thing will vary widely. Even if it were possible to start a group on the same level, it would scatter immediately,

owing to variations in intelligence, interest, environment, and many other factors. In no group, however carefully selected, will we find equal ability to assimilate ideas. Ignoring this basic fact leads to discouragement, wrong attitudes, and dissatisfaction with school work on the part of the pupils. It is a manifest absurdity to undertake to present the same facts in the same length of time to all members of a large group.

77. When Mass Instruction Is Expedient. Mass instruction may be expedient at times when the entire group needs to know the same thing at the same time, and when the information is limited in extent, not dependent upon previous instruction, general in character, and not requiring exactness in detail; but effective teaching demands that we recognize learning as an individual process.

78. Teachers in Industrial Field Recognized the Difficulties. Teachers in the industrial field were among the first to recognize the difficulties of mass instruction. They could not easily ignore the wide variations in abilities. Each day there was left with them a permanent record in the form of a visible product. No concealment was possible. The influence of custom is so great, however, that they thought it necessary to follow the plan of class instruction and resorted to many devices[1] to "keep the class together." The best they could do was to follow the practice in other subjects, withhold instruction until a majority of the class was ready for it, and supplement this by individual instruction.

[1]Chas. A. Bennett, *The Manual Arts*, The Manual Arts Press, 1917, pp. 68-84.

Many people in the field of general education regard the problem of individual instruction as a sort of "mouth-to-ear process," in which one pupil occupies practically the entire time of one teacher. They overlook the fact that teaching does not consist in telling something or in giving information, but in placing a pupil in a position where he must assemble his resources, develop them, and use them in the solution of his problems.

79. The Ideal Situation. The ideal situation in training is one in which every youth has a task that calls for the exercise of his best ability, and in which no one has a task that is beyond him when he uses all of his resources. Only individual instruction can provide such a situation.

80. Teaching an Individual Process. Teaching is an individual process, just as learning is an individual accomplishment. We must never forget that we are teaching individuals, although they may be assembled in groups. All learning conditions, such as intelligence, interest, attention, and readiness, are individual conditions, and vary with the individuals. We never have the same degree of interest, or readiness, among all the members of a group, nor the same ability nor the same background of experience, nor do we have the same aspirations for the future nor an equal willingness to strive for a common purpose. These things are individual and personal, not group qualities and characteristics. They affect learning and our methods of teaching only as they affect the individuals of the group. It is necessary that the arrangement of our

instruction material be flexible enough to meet these individual situations.

In order that individual instruction may be carried out effectively and economically, it is necessary that instruction be prepared and assignments made on the basis of the specific things we wish to teach. If the material is organized on the basis of definite learning units these may be presented at any time and in any quantity necessary to meet the individual needs. Different types of such material require different methods of presentation and assignment, but in most cases accurate instruction may be given more effectively in written form than orally. This is particularly true if free use is made of illustrations. Some pupils have more difficulty than others in reading instructions, but this difficulty is present in all their work, and is one of the misfortunes of the less gifted pupils. There is no more basis for objecting to written instruction because some children do not read well than there is for objecting to the use of text-books for the same reason. If the instructions are well written, adequately illustrated, and sufficient time allowed for study, even the dullest of the group will be able to understand them.

Many teachers object to written instructions because they feel that instructions that are simple enough for the less gifted pupil to understand are too simple for the brighter ones. It must be remembered that instructions and directions are not ends in themselves, but are the means supplied by the teacher to enable the learner to solve his problems. In order to solve a problem it is necessary to have an adequate back-

ground in knowledge and experience. It is the teacher's business to provide this, and every individual must get it whether he is bright or dull. The bright individual will get it much more quickly than the dull one, but there is no virtue in making it more difficult for him. Make all instructions available in as easily understood a form as possible, and while the bright pupil will get them more readily than the dull one he is not delayed in their application. It is the teacher's job to provide the instructions in the simplest form; it is the pupil's job to understand them and to use them.

It is in planning the execution of the tasks, or in using the instructions, that the greatest differences in ability are manifest. In this phase of the work the teacher has an opportunity to take into account the differences in the abilities of the individuals, and to assign tasks that will call for the best efforts of each.

81. Advantages of Written Instructions. Individual instruction may be given in oral or written form, but written instructions have certain very decided advantages. They constitute a most valuable teaching device, but it is not intended that they should supersede all other means of instruction. They must be well prepared, and the work must be organized and planned so as to make provision for that particular method. Many difficulties and disappointments will be encountered, if we undertake to use written instructions with the same organization as that used for oral group instruction. When the instructions are well written, and the work properly organized, they have the following distinct advantages as a method of teaching:

1. There is ample time to select the material with great care. The material may be examined and criticised to make sure that every element is present that will help to emphasize and make clear the main point, and that nothing is included that will tend to divert the attention from the specific thing to be learned.

2. There is time to examine the instructions and arrange them in the most effective learning order. One of the most common defects of oral instructions is the lack of proper sequence.

3. They are briefer and more accurate than oral instructions. The best method of verifying this is to compare the written instructions with an accurate stenographic report of the oral presentation of the same subject. Most teachers are surprised at inaccuracies, repetitions, awkward expressions, and unrelated matter which they find in a stenographic report of even their best oral presentations.

4. They are in permanent form. If the pupil fails to understand the instructions at the first reading, he may read them again, while he must remember oral instructions from a single statement. Oral instructions tend to fade as soon as given, and the impression becomes fainter and less accurate with the passage of time.

5. They place the responsibility for getting the instructions on the pupil, where it belongs; and instead of being passive or receptive he must become an active seeker.

6. They develop a feeling of responsibility and self-reliance. Ample instructions are provided, and he is

held responsible for using them in the solution of his problems.

7. They are much less expensive than oral instructions because larger groups may be handled effectively. The initial expense is large, but the use will spread over a long period of years; and when the plans are well organized a teacher may handle a larger number of pupils effectively with a smaller expenditure of energy.

8. They give ample time for the teacher to give individual oral instructions when such instructions are needed. An organization plan similar to that given in Chapter V will make this possible.

82. Disadvantages of Written Instructions. The principal difficulties that arise in connection with written instructions are:

1. That our teachers have not been trained in the technic of preparing or using such instruction material. This is true, and it presents a serious difficulty, but one which we may overcome by training. We train in the technic of oral group instruction, and we may just as well train in the technic of individual written instruction.

2. Professional training, tradition, and experience are opposed to it. This presents a difficulty but not an objection. Training and experience can overcome it.

3. The initial cost of preparing the instruction material is large because of the illustrative material required and because few teachers have developed skill in the written presentation of the material. This presents the most serious difficulty. Comparatively few teachers can make drawings with sufficient skill to illus-

trate adequately the instructions. It must be granted, also, that writing satisfactory instructions is one of the most difficult forms of English composition. We may be justified in suspecting, however, that one who is unable to give clear and definite instructions in writing will not do any better when he attempts it orally.

4. Many pupils have difficulty in getting information from the printed page. This is true, and it applies with equal force to all text-books and printed material.

5. Special situations sometimes arise which cannot be foreseen when writing the instructions. This is true, and it is on these occasions that the written instructions must be supplemented by individual oral instructions.

6. They reduce the opportunity for the development and exchange of ideas through class discussion. This may be amply provided for through reports and group discussions of social problems of general interest which do not have a prerequisite in formal training.

When the instructions are not well written, or when the teacher does not have his work well organized, or if he fails to appreciate the real use to which the written instructions are to be put, or if he is indolent and careless, we are likely to hear, in addition, some of the following objections:

1. That, when a student is confronted by a difficulty and appeals for assistance, the teacher says, "Get it from the instruction-sheet."

Such a practice may be either good or bad. If the matter is adequately covered by the written instructions, and the teacher may rightly expect the student

to get the information from that source, it is good; but if the teacher gives such an answer because of his indolence, and without due consideration as to whether the appeal for assistance is justified, it is bad; and such a teacher would probably do unsatisfactory work under any conditions.

2. It is also said that in some cases the student is unable to follow the written instructions, and that teachers find it necessary to demonstrate the use of tools to individual pupils and at times, perhaps, to groups, in order to establish good ideals of workmanship.

This is true, but it is only saying that for certain phases of instruction, and for certain individuals, the written instruction-sheet is not wholly adequate. This objection is similar to the boy's objection to the chisel, when he complained that it was unsatisfactory because the edge broke off when he drove screws with it.

3. It is said that the written instructions do not convey the atmosphere of the trade or industry and that the work, therefore, lacks guidance value. It is a mistake to suppose that the endless talking of a teacher gives "trade atmosphere," or any adequate knowledge of an industry. As a matter of fact, a written instruction-sheet in the form of an assignment, constitutes, perhaps, the best possible method of acquiring information upon which a fair judgment of the range and character of a vocation can be based. It also gives experience in acquiring technical information from printed forms which will be necessary if he is to make progress in a vocation after leaving school.

4. The objection is sometimes urged that written instructions permit the bright pupils to advance rapidly and thus discourage the duller ones.

This probably is not true; but even if it is, we should not retard and discourage the brighter pupils in order to avoid discouraging the less fortunate ones.

5. Some critics object to the written instructions on the ground that the instructions do not tell enough, and that the pupil must proceed on the trial and error method, while others maintain with equal assurance that the instruction-sheets tell everything and leave the pupil nothing to think about.

These objections may be justified for particular instruction-sheets, but do not apply to those properly prepared.

6. Another objection sometimes offered is that the student is uncertain, and makes many blunders and mistakes in doing a job, which he would not make if the instructions were oral.

In so far as this objection is valid it arises out of a lack of knowledge of the proper methods of procedure. No student should ever be permitted to start on a job until he has it carefully planned, knows every step he is going to take, knows how to take each step, and is fully aware of any dangers involved. This is simply good teaching practice whether the instructions are given in oral or written form.

It is only fair to say that these difficulties are not inherent in the written instruction-sheet, but arise because the material has been poorly prepared, or the teacher is uninformed as to method, and does not have

his work properly organized, or because he is careless and indolent.

83. Difficulties in Preparing Written Instructions. Many teachers have met with notable success in the preparation of written instructions, but others have not been satisfied with results. In the first place, written instructions must be selected with much greater care, and must be more carefully organized than oral instructions, because the writer has no opportunity to clear up obscurities.

Second, they must be clear, brief, and exact. They must be clear, because many students do not get information readily from the printed page, and care must be taken to remove every obscurity, if possible. They must be brief, because every unnecessary word tends to confuse, and to distract attention from the main point. They must be exact, because they are the only guide, and the one who uses them must have complete confidence in them.[2]

Another difficulty lies in the fact that we have not yet developed a satisfactory technic in the use of written instruction material. Every tradition of our schools, all our classroom procedure and methods, and our entire physical set-up, are based upon the idea of oral group instruction, and these facts must be taken into consideration when we attempt to change to a new plan. It is necessary to abandon the formalism of the old group methods, and plan our practice in such a way that we can give each pupil the instruction he needs when he needs it and be able to check him accurately on the results of his efforts. This change is

[2]See Chapter XVIII, p. 344.

necessarily a slow one beset by many difficulties because of the variety of factors involved, but we cannot hope to succeed as long as we try to use a plan developed for oral group instruction.

84. Instruction-Sheets Deal With Specific Learning Units. They are not general treatises on subjects, but center attention on the particular things to be learned. Their value as instruction devices for imparting information, for directing study, or for instruction in matters of skill, depends largely upon the discriminating judgment and care with which they are prepared and our willingness to reorganize our classroom practice to permit individual progress. The problem of writing instructions is somewhat simplified if we take the list of learning units and write out the instructions we would give orally for each unit. In writing the instructions the unit should be considered without respect to its relation to a particular job, in order that the instructions may apply to any job in which that unit is involved. We should be able to put in written form any instructions we can give orally, and in most cases they will be briefer and more accurate.

85. Types of Written Instructions. One of the most prolific causes of failure in the attempts to write instructions is the fact that writers do not distinguish between the different types of learning units. Different types of units require different methods of presentation. For example, the organization of the instruction material to aid a boy in learning how tin plate is made would be different from the organization required for teaching him how to find the circumference of a vessel

when the diameter is given. A different method of organization and instruction would be required to teach him soldering. The method of procedure in developing skill is quite different from that required in developing thought and reasoning. This, of course, is just as true in the case of oral group instruction as it is of written, but it is much easier to conceal it or ignore it in the case of oral instruction.[3]

The classification of the learning is a matter of convenience in developing type forms of instruction-sheets. If at any time a doubt arises as to which type of instruction-sheet to use for a particular learning unit it is probable that either type would do equally well or a combination of the two may be used. Very little time should be spent in classifying doubtful cases. Prepare the necessary instructions and let the classification take care of itself.

There are four recognized types of instruction-sheets which, with slight variation, will cover the various types of learning units.[4]

The term *Instruction-Sheet* is a general term applied to all forms of written or printed instruction sheets purporting to give instruction, and the proper use of this term will aid greatly in clearing up difficulties. The name of a special type of instruction-sheet should not be used as a general term to cover all types. The failure to observe this distinction indicates a lack of discrimination. The following outline shows the type forms coming under the general heading:

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[3]See Chapter XII, p. 256; Chapter XIII, p. 269.

[4]R. W. Selvidge, *Individual Instruction Sheets,* The Manual Arts Press, 1926.

INSTRUCTION-SHEETS

1. *Operation-Sheet.* This sheet deals with the learning units that involve skills, and gives definite instructions for performing the operations.

2. *Information-Sheet.* This sheet gives facts or information concerning tools, materials, or other matters connected with the vocation. It deals with that phase of information that gives a background for the work of the trade.

3. *Assignment-Sheet.* This type of sheet is used in making assignments for investigation, and in the presentation of problems and scientific principles. It is a most valuable type of sheet.

4. *Job-Sheet.* This sheet undertakes to tell how to do a complete work job. It includes every phase of instruction necessary in doing the job and is adapted to quantity production.

All written instruction material may be classified under these four types, and if we observe carefully the characteristics of each type, and know the conditions for which each is adapted, we shall be able to proceed without difficulty in the preparation and use of written instruction material.

86. Operation-Sheets. Operation-sheets deal with the learning units involving the manipulative operations we wish to teach. These operations, or units of instruction, consist of such fundamental skills as: "How to Saw to a Line," "How to Set a Stick to Measure," "How to Fill a Ruling-Pen," "How to Center a Piece of Stock in a Lathe," and the like. It will be observed that these skills are involved in many jobs, and instructions prepared for one of the units may be used on any job in which the skill is involved. They may be taught as individual units unrelated to a job, but in general it is not advisable to do so.

Such units of instruction involve the development of skill, and all instruction designed to develop skill must follow closely the laws of habit formation. Skill rep-

resents the best practice yet discovered in performing an operation, and we should not expect pupils to discover a better one. Therefore, the method of presentation and the procedure in teaching skills call for dictation or demonstration on the part of the teacher, and for imitation and the careful following of directions on the part of the pupil.

Skill is not a matter of thought and reasoning. It is a habit which can be developed only through drill, and any variation or departure from standard practice will hinder or delay the formation of the desired habit. Drill in school for the purpose of developing habits or skills has been in disrepute for some time, on account of undue emphasis on the theory of self-activity and interest, but they can be developed in no other way. They represent fixed and accepted practices developed through long experience, and their form should not be left to the whimsical interests of youth.[5]

Instructions prepared with a view of developing skill should be in the form of specific directions and not in the nature of general advice.

It requires rather keen and discriminating judgment to determine just how much information should be in an instruction-sheet telling how to perform a manipulative operation, and it is rather difficult to give a definite rule by which we may be guided. Perhaps the best we can do is to say that in such an instruction-sheet we should give any information that will aid one in performing the operation, but nothing of a general character which will tend to divert his attention from the doing operation it is desired to teach.

[5]See Chapter XV, p. 307.

For example, suppose we are writing instructions to tell "How to Bore a Hole With an Auger-Bit." We may start in this fashion:

"1. Select a bit of the required size. You will find a number on the shank of the bit which indicates its diameter in 16ths of an inch. The figure 8 indicates eight sixteenths, or ½ inch; the figure 10, ten sixteenths or ⅝ inch; etc."

Such information is highly desirable and directly helpful in the task before the student. However, it would be quite inappropriate and distinctly to his disadvantage to incorporate in the instructions information concerning the manufacture or the types of auger-bits. Such information doubtless is desirable, but it should not be presented at the time the boy is trying to learn the proper method of handling the bit. It may well be an assignment following the completion of a job in which the use of a bit is involved, but the boy should not be interrupted in the performance of his task.[6]

It would be inadvisable, for the same reason, to describe the manufacture of high-speed steel in an instruction-sheet, telling "How to Turn a Cylinder in an Engine Lathe," although it would be quite appropriate to say that if a high-speed-steel bit is used he can make a faster and deeper cut than with an ordinary carbon-steel bit.

87. Suggestions for Preparing Operation-Sheets. If the following points are observed in preparing instructions dealing with skilled operations the problem will be greatly simplified:

1. The title should clearly indicate what instructions

[6]See Chapter VII, p. 152.

are given, as "How to Pull a Proof." Such a definite title helps the writer to stick to his subject, and the learner will know from the title whether the instructions will tell him the things he wishes to know.

2. The instructions should deal with the learning units involved in work jobs, but without respect to any particular job. Many teachers make the mistake of writing the instructions for a particular job and insert details which are not applicable to other jobs.

3. The instructions for performing the operations should be given step by step in a very complete form, and the sentences should describe the operation in the order of movement, so that the understanding of the movement will flow along with the sentence. Avoid inverted sentences and other literary tricks used to give variety to expression.

4. In general, it is not advisable to explain why an operation is performed in a certain way. The "Why" should be taken up in questions to give the boy an opportunity to do some thinking. The "How" is a matter of direction; the "Why" is a matter of thought.

5. Illustrations should be given to clarify written instructions. The generous use of illustrations will add greatly to the usefulness of the instructions. A small marginal illustration often is more instructive than a paragraph of written instruction.

6. Give only the information necessary in performing the operation. Do not obscure the instructions for a manipulative operation by giving general information.

7. In most instances it is well to add questions to an operation-sheet in order to encourage the student to

seek the reason for doing things in a particular way, but questions should never be asked unless they have a real purpose.

8. Give references to available sources of information if additional information is needed.

88. Information-Sheets. Information-sheets deal with those units of instruction represented by simple statements of fact which one is expected to know who occupies a position in the industry or society that corresponds to the one the learner expects to attain. These units of instruction may be matters of general information, such as historical or geographical facts, or information about industrial materials, or they may deal with facts that are important in planning jobs. For example, the source and the extent of the supply of tin might be an item of information worth while to one preparing to enter an industry in which tin is used. The method of manufacturing tin plate might be a unit of instruction which would be regarded as worth while for a sheet-metalworker, although neither of these would have any direct bearing on the skills of the trade. The knowledge of the commercial sizes and kinds of tin plate would be directly valuable in the practice of the trade.

Knowledge of the qualities or characteristics of materials often is of great value to the worker in the selection of material to meet certain conditions. Frequently a mechanic must have certain information in order to plan his job properly. For example, an electrician must know the underwriters' rules, and a plumber must know the part of the building code that concerns plumbing; the knowledge of the effect of heat

on the expansion of metals would be important to the steam fitter in planning his job in order that he might overcome the effect of the expansion in pipes.

89. Suggestions for Preparing Information-Sheets. The following points should be kept in mind when preparing Information-Sheets:

1. The title should clearly indicate the subject treated, as: "Opportunities and Requirements in the Machinists' Trade," "The Types of Bond in Brickwork," "How White Lead is Made."

2. The information should be given in brief statements, and without discussion.

3. Questions should be given to act as a guide in reading and observation and to form the basis for group discussions.

4. References to available, additional sources of information should be given. Long lists of references are undesirable. One or two of the best is all that is necessary.

90. Assignment-Sheets. The Assignment-Sheet is of very great value in all forms of learning units involving investigation of industrial practices or the application of the general principles of mathematics or science. The form used for the study of industrial practices is illustrated on pages 38 and 39.

The special form of assignment-sheet used in the presentation of general principles is so arranged as to provide opportunity for practice in their application. Such a type of instruction-sheet is of special value when the units of instruction deal with the problems of science and mathematics, or, in fact, any line of work in which general principles or rules of action may

be stated. Such an instruction-sheet usually involves a definite statement of the principle it is desired to teach, together with examples of its application. These examples are sufficient in number to give adequate illustration of the application of the principle. This is followed by a number of problems or jobs involving the application. These should be so arranged as to give sufficient practice to fix firmly in the mind of the pupil the principles involved.

Examples of this form of Assignment-Sheet are shown on pages 194 and 195.

91. Job-Sheets. The term Job-Sheet is applied correctly only to those forms of instruction-sheet that tell how to do a complete work job. It deals with a simple job as the unit of instruction. Only very small standard jobs may be handled successfully on this basis. The more complicated jobs contain too many elements of skill in which instruction is required. To attach a coupling to a garden hose is a simple job involving only three or four points of instruction, and these points are so small and so unrelated to other jobs that the whole may be treated as an instruction unit. Making a chair is a job also, but it involves far too many elements to be properly treated as a unit of instruction. Such a job involves a number of instruction units.

Since a job-sheet must be prepared for a specific job, many teachers have difficulty in using it. They do not wish to do that particular job in that particular way, and as soon as the job is modified, the job-sheet ceases to function as satisfactory directions for doing it. This is unavoidable, and few teachers are willing to be bound down to a fixed series of standardized jobs.

In general, it appears to be better to prepare instructions covering the fundamental operations of the trade which occur frequently in a great variety of jobs. Instruction in these operations is then available without respect to the jobs in which they are involved.

The following outline for a Job-Sheet is taken from *Individual Instruction Sheets.*[7] If Job-Sheets are to be prepared this outline will be most helpful.

OUTLINE FOR JOB-SHEET

The following outline is offered in the belief that job-sheets written on this plan will have in them provisions for placing responsibility upon the student to as great an extent as is possible in a job-sheet, and will greatly improve them as devices for instruction.

1. *Title.* State the exact title of the job so clearly that there is no doubt about what the instructions will cover.

2. *General Directions.* Under this head should be paragraphs stating four distinct things:

(a) A direction to examine an exhibit of similar work to determine how it was done.

(b) A statement that the student must read carefully the entire job-sheet, and make a list of the steps he will take in doing the job. This is his job plan.

(c) A statement that the student must make a list of the tools and materials required for the job.

(d) A statement that both lists must be approved before starting work on the job.

3. *Specifications.* A statement of the requirements of the job. This constitutes the specifications for the job and should contain all drawings, dimensions, and kinds of materials to be used, if any special material is required. It should be a very definite statement of what is wanted.

4. *Information.* A brief statement of any facts or information that may be needed in order to do the job successfully.

5. *Directions.* Directions for doing the job. These should be stated briefly and in simple language. The different steps should be set off in distinct paragraphs. Use illustrations freely.

[7] R. W. Selvidge, *Individual Instruction Sheets,* The Manual Arts Press, 1926.

6. *Checking.* A statement that the work must be finally checked at this point.

7. *Questions.* Carefully chosen questions to point to the general application of the things learned in doing the job. Avoid irrelevant questions.

8. *References.* Give one or two good references if needed. If references are given they should be exact as to page.

92. Some Things to Avoid in Writing Instruction-Sheets. Avoid such divisions of the instruction-sheet as, "Reasons for the Job," or "Purpose of this Instruction-Sheet." Unless the reason for the job is perfectly apparent to the boy and he feels a need for it a formal statement of the reason will have little value. It certainly will not be sufficient to create interest. Interest in a job can best be created through an opportunity for the boy to observe drawings, pictures, and examples of useful and well designed articles available for instruction purposes, and an individual conference with the teacher.

Remember that "Specifications" tell what is required, and do not give instructions. They should be clear and definite, and should not include a discussion of the usefulness of the article.

Avoid long paragraphs. They are uninviting and generally unnecessary. Avoid asking questions that do not have a direct bearing on the particular instruction unit. An irrelevant question is as inexcusable as an irrelevant sentence in the middle of a paragraph. Do not give references unless they will make a real contribution and you expect them to be used.

Do not try to tell all you can. Tell only what you believe to be necessary. An unnecessary sentence is a handicap to the student.

Avoid such indefinite expressions as "the proper amount."

93. Duplicating Instruction-Sheets. Some very satisfactory instruction-sheets have been issued by publishers, and recently there has been a marked improvement in form and content. They have been issued in loose-leaf and in bound form. The bound form probably is more economical because of greater durability.

When satisfactory instruction-sheets can be purchased from a publisher it is far more economical to do so than to attempt to duplicate the instruction-sheets in the school; but in many cases it will be impossible to get satisfactory published instructions for certain learning units, and these must be written and reproduced in the school.

The two methods most generally used are blueprinting and mimeographing. Mimeographing is much less expensive if a large number of copies are required. Illustrations may be drawn on a stencil and reproduced on the mimeograph as readily as it can be done by tracing and blueprinting. A little practice will enable one to get good results with drawings on a stencil.

One caution is necessary. Do not duplicate an instruction-sheet until it has been examined, criticised, and revised with the greatest care, and until you are sure it is practically free from defects. In our earlier efforts there was some excuse for poorly organized instructions, but the essential elements of the various types of good instruction-sheets are now so well established that we have good standards for the critical judgment of our work. Never duplicate an instruction-sheet until you know it gives in a clear and readily

understood form the instructions you wish to give.

If all the instruction-sheets are to be prepared by the school the following suggestions will be helpful. It is not necessary that each pupil have a complete set of instruction-sheets. By giving a little thought to the shop organization it will be possible to arrange things so that a supply sufficient for the largest section will be adequate. If this plan is undertaken it will be found desirable to provide pigeon-holes or some sort of filing-case in which to keep the instruction-sheets. This "knowledge case" should be so located that it is readily available to all students.

The instruction-sheets should be prepared, either blueprinted or mimeographed, and mounted on a durable, light weight, fiber board of some kind, and placed in the pigeon-holes, which should be properly labeled with both number and name of the learning unit. For the first ten or twelve units, or those involved in the first two or three jobs, there should be an instruction-sheet for each student in the largest section to be accommodated. The number required for the succeeding units will decrease rapidly, and for many of the units a number equal to one-fourth the number of the class will be sufficient. This is due to the fact that the class will quickly separate, and comparatively few will need the same instructions at the same time.

It is not necessary for a student to keep all of his instructions before him all of the time. After he has used the instructions for a given learning unit in one or two jobs he probably will not need to consult them on subsequent jobs; only the instructions for the new units will be required. When the student submits his

job plan he will be required to secure the instructions for any step with which he is not familiar. He will not need the instructions for the things he already knows.

94. Written Instructions Not Only Means of Individual Instruction. Individual instruction does not consist of a single method of presenting subject-matter. It means a combination of all the methods, with due regard to individual needs and individual progress. The teacher must remember that learning is an individual process, and that he must use every resource at his command to meet the needs of individual cases. The written instructions have many advantages, but problems will arise in connection with their use which will require the personal attention of the teacher. Difficulties in reading, imperfections in the instruction-sheets, individual learning habits developed early in life, and the nature of the pupils' learning mechanisms, are all factors which demand the personal attention of the teacher. Written instructions are not intended to displace the instructor, but are devices which enable him to carry on individual instruction effectively.[8]

95. Other Individual Instruction Devices. One of the most important supplements to the written instructions is a series of exhibits in the shop showing the principal steps or stages in the performance of the more important operations. These should be arranged in order and numbered, and explanations attached where necessary. This is particularly valuable if the written instructions are not well illustrated.

Exhibits of materials showing the various steps in

[8]See Chapter XIII, p. 269.

the manufacture of articles are available in many lines.[9] In other lines printed material is available with excellent illustrations. Exhibits of materials should be prepared giving sizes, names, and principal uses.

If we are to carry on individual instruction, and encourage individual progress, we must prepare our instructions so they will be available to any student at any time he needs them. We should surround him with opportunities to learn the things he needs to know.

96. Group Instruction. In pointing out the necessity for individual instruction, and the essential elements involved in carrying it on successfully, it is not intended to suggest that there is no place for group meetings and group discussions. In certain types of work, group discussion is most valuable. It helps to clarify ideas, develops new points of view, aids in oral expression, promotes an appreciation of the opinions of others, and has a decided socializing effect. Perhaps its most useful field is in developing attitudes with respect to social questions. In such questions the keener and more discriminating minds of the group may have a very favorable influence on the duller and less discriminating.

97. Summary. It has been established by careful investigation that there is a very wide range in the learning abilities of individuals, and we are confronted with the task of providing instruction that will permit individual progress.

A system of grouping on the basis of ability reduces the range of differences, but it does not solve the dif-

[9]H. J. Smith, *Teaching Aids for the Asking,* The University of Minnesota Press, Minneapolis, 1928.

ficulty. In many cases such a grouping is impossible.

Mass instruction is expedient when the entire group needs to know the same thing at the same time, and when the information is limited in extent, not dependent upon previous instruction, general in character, and does not require exactness in detail.

Men in the field of industrial education have been leaders in pointing the way to an organization of instruction material, and in the development of a method of teaching that will provide for individual instruction and individual progress without increasing the cost per pupil.

The ideal situation in training is one in which each youth has a task which calls for the exercise of his best ability, and in which no one has a task that is beyond him when he uses all his resources.

Teaching is an individual process just as learning is an individual accomplishment. Some pupils will have more difficulty than others in reading instructions, but this difficulty is present in all their work, and is one of the misfortunes of the less gifted pupils.

There is no more basis for objecting to written instructions because some children do not read well than for objecting to the use of text-books for the same reason.

Different types of learning units require different types of instruction.

Instruction-Sheet is a general term applied to all forms of written or printed instruction-sheets. There are four recognized types coming under this general heading: Operation-Sheets, Information-Sheets, Assignment-Sheets, and Job-Sheets.

Written instructions should not be regarded as the only means of giving individual instruction.

98. Observation Problem.

Assignment: Go into the classroom, and after a few minutes of careful observation of the group select a pupil whom you judge to be one of the best of the group; also select one whom you judge to be among the poorest of the group. Observe carefully the movements, attitudes, and work of each pupil, and answer the following questions:

1. What were the factors that caused you to select one student as the best and the other as the poorest in the group?
2. In your judgment what is the cause of these differences?
3. Are both students doing the same kind of work?
4. Does each appear to have had adequate instruction?
5. If either one needs additional instruction does he appear to be aware of his need?
6. Do any other pupils appear to need the same instruction?
7. Are the instructions so organized that they are available to a student when needed?
8. Is the class kept together in the same work? If so, how is it done? If it is not, how are instructions given?
9. What are your suggestions for improving the situation?

QUESTIONS—CHAPTER VI

1. What are the advantages of group instruction?
2. What are the chief difficulties involved in group instruction?
3. What are the principal devices used to overcome them?
4. What are the principal advantages of written instructions?
5. What are the principal disadvantages of written instructions?
6. What are the principal devices used to overcome these disadvantages?
7. What are some of the principal things that would be involved in the successful introduction of individual instruction in our school system?
8. What are the principal types of instruction-sheets?
9. What are the characteristics of each type?

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CHAPTER VII

Our Teaching Plan

99. Steps of the Teaching Plan. Having discussed the problems of selecting our instruction units, arranging the material for instruction purposes, and the preparation of the instructions in order to permit individual progress, we now take up the problem of using this material in teaching.

It is just as necessary for the teacher to have a job plan for his teaching project as it is for the boy to have a job plan for the job he is to do. The teacher's plan, like the boy's plan, consists of a list of the steps he will take in doing the job, arranged in the order he will take them. The principal steps of the plan, and the order of their arrangement, are pretty well fixed for all types of teaching units. There may be variation in the details, but the general divisions of the plan will be the same in almost any trade or industrial teaching problem. The plan differs considerably from the old type of lesson plan with its five formal steps, devised for academic subjects; but it follows the best practice in industrial teaching, and is based upon individual instruction.[1]

1. *The teacher must provide a situation in which there will be desire or readiness to learn.*[2]

It is impossible to teach one who does not desire to learn. If the desire does not exist, the teacher must

[1]R. W. Selvidge, *Individual Instruction Sheets,* The Manual Arts Press, 1926, pp. 90-97.

[2]See Chapter XI, p. 238.

create a situation which will develop it. Usually this is done indirectly by developing an interest in something that will satisfy an immediate want, the attainment of which will necessitate the learning of the things we wish to teach. This indirect method has its advantages, as the realization of the values of some of the things we wish to teach is so remote in time that it is difficult to develop direct interest in them. Very few young people are interested in remote rewards. The nearer the reward in point of time the greater the interest.

There is such a variety of interesting and useful projects available for use under school conditions that not many teachers find difficulty in arousing interest in undertakings which involve the things they wish to teach. The difficulty usually arises in maintaining interest until the project is completed. In view of this it is best to assign simple tasks at first which can be completed in a relatively short time, so as to give the satisfaction which comes from the feeling of having completed a task. This is of very great value.

Another important factor in maintaining interest is recognition of the accomplishments of the individual. If the boy knows there are certain definite things to be learned, and that he will receive public recognition on the Progress-Chart when he has established his proficiency in any of them, it acts as a powerful incentive in his work, and the more emphasis we place upon the importance of the Chart the greater the incentive to effort. A system of tests for proficiency in the learning units before a final rating is given will have the effect of emphasizing their importance. We have excel-

lent examples of the effect of this in the Boy Scout work.

There are many other avenues through which interest may be aroused, such as a desire to excel, a desire to engage in some constructive activity, or a desire to possess some article which the individual judges to be useful. All of these motives should be used in developing interest, as the stronger the desire to learn the more successful will be the teaching.

Attractive, well-designed, useful projects or jobs involving the elements we wish to teach are perhaps the best means of creating this interest in industrial arts and beginning trade work. It is not difficult to arouse interest in such projects nor in developing the skill necessary to make them. In selecting the list of standard jobs this factor should be taken into account, and as wide a variety of projects as possible should be provided. Exhibits, drawings, and pictures aid in arousing interest and inspiring a desire for accomplishment. The teacher must not overlook the fact that interest is emphasized as a motive, and as a factor in determining methods, but not in determining subject-matter. Interest may determine the field in which an individual will choose to work, but the requirements of society determine what we shall teach in that field.[3]

2. *The teacher must assign jobs or tasks that involve the learning units he wishes to teach, and the assignments must be so clear and definite that the learner will know exactly what is required.*[4]

At the beginning the teacher should select from his

[3]See Chapter XVI, p. 319.
[4]See Chapter XVI, p. 319; Chapter XVII, p. 332.

list of standard jobs a very simple job that involves the things he wishes to teach at that time. He should be sure that the job is within the capacity of the student, and he should then hold him to a strict performance of the task. Do not change an assignment or relieve a student of his responsibility because he finds the task difficult. To do so will lower his standard of performance, diminish his self-respect, encourage habits of laziness, and develop the tendency to quit when confronted by difficulties.

For every job there should be well prepared drawings, if drawings are necessary, and complete specifications with respect to finish, material, and any information necessary to make sure that the product will be exactly what is required. In many cases it is desirable to have the pupil design the job, as in the case of a display advertisement, title-page, or letter-head, but this should always be done and approved prior to starting in to set the job.

In a suggested project in woodwork the pupil may desire to make certain changes in the design. There can be no objection to this, but he should be required to make all the changes on the drawings and specifications before he begins work on the job. In trade work and in production work generally the drawings and specifications are not subject to change, and the learner knows what is required. Every new job, whether it is proposed by the pupil, or comes from an outside source, should be treated in the same way. The pupil should be made to understand that these are the requirements from which he should not vary. Few teachers realize the importance of this.

In order to be sure that every detail of the requirements is understood the student should go over them with the instructor. More failures result from the want of understanding of what is required than from all other causes combined.

3. *The student should be required to analyze and plan the procedure for the job that has been assigned.*[5]

This is the crucial point in teaching. No other single factor compares with it in importance. If the material has been prepared as suggested in Chapter V, he will have the plans and specifications and lists of the learning units involved in doing the job. With this as a basis he will have little difficulty in picking out the major steps he will take in doing the job, and a few questions will bring out the minor ones. He will soon discover that the learning units do not constitute the steps of the plan, nor will they be arranged in the sequence in which they will occur in the job.

In making the job plan the students should first examine the drawings and specifications, and then list the steps he will take in their order. The teacher should look over the plans very carefully to see that it includes all necessary steps arranged in a satisfactory order. A recent examination of his own plan for the job will aid him in making a quick and accurate examination of the pupils' plans. Different orders of procedure often are equally good. The pupil should be questioned as to his method, and if he can give a good reason for it he should be permitted to follow his plan although it may not be the usual order.

The plan of the job should never be neglected. It

[5]See Chapter XV, p. 307.

is a matter of thought and reasoning, and represents the highest type of mental effort. The ability to plan marks the distinction between the capable high-grade mechanic and the low-grade journeyman, who can do only the things he is told to do. In our daily life we must discover the requirements of our tasks, and bring to bear on them all the resources of our training and experience in order to solve them. The one who can analyze a job to determine its requirements, and choose wisely from his resources the elements necessary in its solution, is the successful man. The teacher who arouses the desire and develops the ability of the pupil to analyze and plan his problems has performed for him a service of inestimable value.

Many teachers who have not tried to teach boys to plan their procedure in doing their jobs believe that it is quite impossible for a boy to learn how to do this. As a matter of fact, most boys will learn to do it in a very short time, and will be proud of the accomplishment. There is nothing mysterious about it. It is simply stating in 1, 2, 3 order the steps they will take in doing the job. If a student cannot make a pretty fair plan of his job, you may be sure that it is too difficult for him, and he should be assigned a simpler one.

It may be objected that even though a boy may be taught to plan his jobs, with a class of 30 or 36 it would be impossible to keep the other members of the class busy while the teacher is consulting with individual pupils concerning their plans. This is a legitimate objection, but it is easy to avoid the difficulty. In the beginning none of the members of the class will know

how to plan their jobs. It is, therefore, desirable to give the entire class instruction in how to plan their jobs, and to show them how to list each step and make the complete plan. If two plans of procedure are made at this time there will be such a wide range of difference in the time required to complete the jobs that they will be well distributed for planning subsequent jobs. Elsewhere will be found a suggested procedure for starting a class in woodwork.[6]

The planning of jobs is such an important part of the training that jobs may be assigned to be planned as outside work, the plans to be discussed in class. Some of these jobs should be carried out by the students in order to verify the correctness of the plans, but it is no more necessary that all of these job plans be carried out in the shop than it is to find practical application for every problem assigned in mathematics. Practice in planning procedures is necessary, and planning consumes such a relatively small proportion of the time required to do a job that a student does not get sufficient practice in planning if he plans only the jobs he does.

Planning the procedure for a job requires careful, systematic thought, and most pupils prefer the more spectacular work of handling tools and materials. They are in a hurry to get to what to them is real creative work, and they do not realize that careful planning will mean saving in time, energy, and material. A teacher should invariably insist upon this definite plan before the work is started.

Much better results will be obtained if a form some-

[6]See Paragraph 101, p. 164.

what like the following is used. The form may be altered, but be careful not to put too much on it.

JOB PLAN

Name .....

Job .....

Date begun.....*Date finished*.....*Time*.....

Procedure:

1.
2.
3. (This job plan card may be made of any
4. convenient size, and the numbers may be
5. continued on the back of the card.)
6.

Are you sure you know how to perform each step of your plan? If you do not, read carefully the instructions dealing with that subject.

4. *The instructor should give all necessary information and directions, and give a demonstration of any new processes involved, if a demonstration is needed.*[7]

When the plan is satisfactory, but before it is approved, the teacher should assure himself that the student knows how to perform each step of the job. If the teacher has any doubt about it he should direct the boy to the necessary instruction-sheets and exhibits dealing with this particular phase of the work, and, after he has studied them, have him explain to the teacher the method of procedure. It will not be necessary for him to read the instructions for the steps of the job with which he is already familiar, but the teacher must be sure that the boy knows the correct method. After the student has familiarized himself with the instructions for each step of his job it will not

[7]See Chapter XVII, p. 332.

be necessary for him to read the instructions step by step during the progress of the work unless the task is a very intricate one.[8]

It should always be the aim to get a very clear understanding of the instructions before the job is begun, and then it will not be necessary to read the instructions again unless some difficulty arises. If the student assures himself that he knows how to proceed in each step of his job plan before he begins his job, the work usually will proceed without interruptions or difficulty.

Definite instructions for all learning units should be available at all times. In addition, the teacher should demonstrate any difficult manipulative operations not made perfectly clear by the printed instructions, drawings, and exhibits. At times it will be well to have a student perform an operation before the class while another reads the instructions. This will establish confidence in the instructions, and give the students the feeling that by the use of the instructions they will be able to work out their jobs without assistance.

Do not hesitate to give a demonstration to a small group or to an entire class, if it appears to be desirable. When all the members of the class or a number of the members need to know the same thing at the same time it is a matter of economy to give the instructions to the entire class or to the group at one time. There is no particular virtue in individual instruction itself. Its value lies in the fact that in general we can do a more effective and more economical job of instruction in that way than in any other.

[8]See Chapter XVI, p. 319.

There is an advantage in giving demonstrations to individuals which usually is not recognized. It is the incidental learning of the other nearby members of the class because of their interest. It is the same element that is present in the one-room country school. Children in the lower grades learn a great deal about the work of the upper grades because they are interested in the recitations and instructions. The voluntary interest which a boy gives to a demonstration that is being given to his neighbor is a much more important factor in learning than the forced attention in a class demonstration.

There should be examples of good workmanship in the shop. They should range from the simple things such as the beginner must do to examples of the more difficult tasks of the skilled mechanic. This is necessary in order that the boy may know what constitutes good workmanship in the field of his immediate problem. Such examples give him a basis of comparison and enable him to form an accurate estimate of his problem. In every shop there should be exhibits of work showing the steps in the various learning units with instructions beneath telling how to perform the particular step. This often is better than a printed instruction-sheet with drawings.

It is the teacher's business to see that all necessary information or instruction is readily available in a form that is easily understood. It is the student's business to use it in the solution of his problems. *Development comes in learning how to relate facts and interpret principles in the solution of problems, and care must be taken that in this phase of his work the*

student has the full responsibility. Many teachers do not distinguish between the responsibility of the teacher for making information and instruction available, and the responsibility of the pupil for using it.

The teacher should be sure that the pupil is familiar with all the topics of information and the facts that may affect the success of his work. His knowledge, or lack of knowledge, of these usually is revealed in his job plan. Matters of general interest in the field may be studied in connection with a particular job, but should not be brought up at a time when it may interrupt the progress of the work.

5. *The student should do his work according to his plan.*

The student having a definite plan of procedure for doing his job, with all necessary instructions available, and knowing how to proceed with each step, will be able to go forward on his own responsibility.

A very careful study of the character of the instructions, or assistance given by shop teachers to pupils after they have started on their jobs, shows that the teacher's activity falls into four general classifications:

1. The clearing up of some indefinite matters concerning the design or specifications of the job, which should have been cleared up before the boy started on his work.

2. Advising the boy "what to do next," which would have been determined in advance if he had prepared a definite job plan showing his order of procedure.

3. Repeating instructions, and giving individual demonstrations which were given to the entire class

but which certain individuals did not get because they were not ready for them, or had forgotten because too much time had elapsed between giving the instructions and the time of using them. Properly prepared written instructions and exhibits would greatly reduce the amount of time required for this.

4. Correcting unforeseen difficulties, which arose because the job was not properly planned and the instructions not understood. Most of this instruction would be unnecessary if the teacher had used care in the beginning to see that the job was properly planned and that the boy knew how to perform each step in the plan.

The plan proposed would not reduce the amount of work a teacher must do, but would use the time in providing an orderly and systematic procedure in giving instructions, and eliminate the waste resulting from the present unorganized plan. If written instructions are not provided much time is lost, because the teacher is the only source of information, and the boy either blunders along or waits for the teacher. Waiting tends to develop habits of indolence and loitering.

Loitering, indecision, or careless and slovenly habits never should be permitted. The teacher should observe the work carefully, and render assistance only where it is actually needed. The necessary material having been placed in the hands of the pupil, he should solve the problem unaided, unless there is danger of his falling into bad habits.

6. *The teacher should check results.*

The teacher should observe the students' work carefully, in order to determine the effectiveness of the in-

struction, and whether additional practice is necessary in order to obtain the desired skill. This gives opportunity to talk to the pupil concerning the virtues or defects of his plan. The teacher should not only check the work at the points he has indicated on the student's plan, but should give a final check on the job, and give a test on any new learning units involved.[9]

7. *Students should report on the job when completed.* When conditions permit it is well to have students report to the entire group when the job is finished. The report should cover such items as: (a) the specifications for the job; (b) time required to do the job; (c) materials used on the job; (d) any special difficulties encountered, and how they are overcome; (e) whether some other plan of procedure might have been better. Such a report develops pride and a laudable ambition to excel in skill and workmanship.

100. Instruction-Sheet for Teachers. Every teacher of experience knows how difficult it is to get a class started properly. For that reason the following instruction-sheet for starting a class in woodwork is given. It will serve to show, also, how written instructions may be prepared for fields other than trade and industrial training. It will be observed that it is divided into three main sections:

First, the things to be done before the class meets;

Second, the preliminary steps to be taken and the general instructions to be given when the class meets;

Third, starting the pupils to work on the job.

101. How to Start a Beginning Class in Woodwork. With slight modification this instruction-sheet would

[9] See Chapter XI, p. 238.

apply to any subject in any shop. The length of the period will determine whether all of this can be done at one meeting of the class. If it cannot, the third division should not be started.

INSTRUCTION-SHEET

I. THINGS TO BE DONE BEFORE THE CLASS MEETS

1. Prepare necessary shop rules concerning such things as general conduct in the shop, safety rules, attendance, system of keeping tools, care of tools and equipment, and any other regulations or practices in which the pupils are interested or concerning which they should be informed.

2. Prepare lists of things with which pupils should provide themselves for use in the course; such as, books, shop clothes, and the like.

3. From your list of jobs select two or three simple ones, with drawings and specifications, which involve the exact things you wish to teach. The list of learning units will be on the back of the drawings, if the jobs have been properly prepared as suggested in Chapter V. You will also have the job plan listing in order all the steps to be taken in doing the job. You should also have a completed model of each job.

4. Prepare and arrange all tools and materials to be used by the teacher in giving instructions. These will consist of such things as: (a) instruction-sheets; (b) drawings and specifications; (c) models; (d) charts; (e) tools; (f) stock or materials required; and (g) Progress-Chart.

5. Prepare materials to be used by pupils, and see that all tools to be used by them are in good condition and in their proper places.

II. PRELIMINARY STEPS TO BE TAKEN, AND GENERAL INSTRUCTIONS TO BE GIVEN, WHEN THE CLASS MEETS

1. Write your name on the blackboard, and secure the names of the members of the class.

2. Pass out copies of the rules.

3. Issue and make a record of all individual equipment, such as tool-checks, plane-iron, etc.

4. Pass out list of equipment to be procured by the pupils.

5. Explain Progress-Chart and how records are kept.

III. STARTING THE PUPILS TO WORK ON THE JOBS

1. Give each pupil a copy of the drawing and specifications of one of the jobs selected; explain the use of the project; and say that this is the first thing that we are going to make. Show a model of the project to the class, and explain the relation between the model and the drawing. This is the first step in reading a drawing. Now read the specifications in order to show the class that the specifications supplement the drawing. Call attention to the list of things on the back of the drawing which they will have an opportunity to learn in doing the job.

2. Proceeding to plan the procedure for the job with the class, say, "What is the first thing you will do in making it?" From their suggestions select the first step that should be done, and write it on the blackboard. In almost every case this will be, "Make out a bill of material;" which, of course, involves reading the drawings and specifications.

3. Continue to question the class about the succeeding steps in the job, and write these steps on the board in their proper sequence. This will insure their reading and understanding the drawings and specifications and will give a fundamental lesson in job planning.

4. When this job plan is completed, pass out the drawings and specifications for a second of the simple jobs you have selected, and proceed without delay or long-drawn-out discussion to make a job plan for it, questioning the class and writing the steps upon the board as before. Compare the two plans and leave them on the board. This will give practice and confidence in planning jobs.

5. When the planning is done, refer to the drawing and plan of the first job, and ask, "What are we to do first?" "Make out bill of material," someone will reply. Then show how to get from the drawings and specifications the size and kind of material required. Show also the conventional method of writing the bill of material. This bill of material should be written out in proper form.

6. Ask, "What shall we do next, according to our plan?" "Get the material," will be the reply. The teacher should then hand to each pupil the stock required, but two or three pieces should be slightly below the required size.

7. Ask, "What next, according to our plan?" "Check the material," someone will reply, as he glances at the plan on the board. Hand a rule to each boy, and have each check his stock. The boys with the small pieces probably will discover that the pieces are too

small. Then emphasize the importance of checking material, even on the simplest job, and give the boys with the undersized stock, material of the required size. One piece may be under the required size in order to see whether they have learned the lesson of checking.

8. Ask, "What shall we do next, according to our plan?" "Square stock to size," will be the reply. This involves the order of procedure in squaring stock. This and the instruction-sheets for the operations should be given to the students. Have some student read the instructions while the teacher demonstrates the process step by step as the instructions are read. This will give confidence in the instructions and encourage pupils to refer to them when a difficulty arises rather than to go to the teacher.

Call attention to the fact that the first three steps of the job plan have now been taken, and that the instruction-sheets tell how to take the steps. Emphasize the importance of taking each step in order.

9. Continue to demonstrate each step of the job plan in the same manner until the entire job is completed. The first job should be so simple that all the learning units of the job may be demonstrated at one meeting of the group. The written instructions will serve to refresh the memories of pupils and make this possible.

10. Place a check mark on the job plans at the points where you wish to check the pupils' work, and say that each one must submit his work for inspection when he has reached that point.

11. When you are sure that each pupil knows exactly what he is to do, have him pass to the bench assigned, taking with him the rule and the stock used in the demonstration, and proceed with his work according to plan.

12. Give assistance only when you are sure it is necessary. Teach students to rely upon their printed instructions.

The length of time required for completing the job will vary widely but the plan for the second job is on the board and the more rapid workers may go on with it. When all have completed the first job, the class should be called together for reports on what has been learned. This will include such things as: Difficulties encountered and how they were solved; what improvements could be made if the job should be repeated; and the like. There will be a wide variation in the time required by various students to finish the first two jobs, and the teacher will have an opportunity to give individual assistance where needed in making subsequent job plans.

102. Assignment of Job and Job Plans. A new job should be assigned as soon as the boy is ready for one. He should be given the drawings and specifications, required to make his job plan, and permitted to proceed as soon as his job plan is approved.

103. The Demonstration. The purpose of the demonstration is to show how things are done, and to show in such a way that those who are being shown will learn how to do the things demonstrated. Many factors are involved in doing this, such as the pupil's interest or feeling of need for the instruction, favorable emotional states, proper attitudes, general physical conditions of the classroom, and so on. It is obvious that the larger the group the greater will be the variation in the personal factors, and the greater the difficulty in making the demonstration meet the needs of all individuals.

104. The Group Demonstration. The group demonstration is based on the assumption that all the learners need to know the same thing at the same time and that they realize this need. If this were really true, group demonstrations would suffice for all instruction; but since this condition rarely exists, the group demonstration is inefficient, and must be supplemented by individual instruction. It does not take into account the problems of individual differences and irregularity of progress. In order to take care of these factors there must be frequent demonstrations and repetitions to small groups or individuals, and this requires a great deal of the teacher's time. While the general demonstration is inadequate for the slower pupils, the more gifted ones are retarded by being required to listen to

unnecessary demonstrations. It is quite obvious that with large classes the difficulties increase rather than decrease. There is such a wide variation in the needs of individuals that it is impossible to make group instruction cover adequately individual needs.[10]

The group demonstration provides a satisfactory means of presenting introductory lessons when instruction-sheets are used, and is effective during beginning lessons which are of immediate interest to the entire group and not restricted to individual projects. But group demonstrations alone are not sufficient, and must be supplemented by individual written and oral instruction and demonstration. Putting over a single lesson requires a combination of forces acting together for each individual and on each individual; converging stimuli are necessary.

105. Basic Principles of the Demonstration. The following principles should be observed when giving either an individual or group demonstration:

1. *There should be a clear and definite statement of the objective.* The learner needs to know exactly what he is expected to learn, and the teacher needs to have clearly in mind the response which is expected of the learner.[11]

If it is definitely understood that the purpose of the demonstration is to show the student how to do something he wishes to do, but does not know how to do, attention is assured. If he does not know the purpose of the demonstration, and does not see a need for it, there is little likelihood that he will give attention.

[10]See Chapter XIII, p. 269.
[11]A. I. Gates, *Psychology for Students of Education,* p. 271.

2. *Every detail of the demonstration should be carefully planned.* With every detail of the demonstration carefully planned, there is much less likelihood that the demonstration will be diverted to some minor matter and the main point neglected. The teacher should have a definite plan to present certain things and stick to his plan.

3. *There should be careful preparation of the instruction material required in the demonstration.* The teacher should prepare and arrange all materials, tools, charts, drawings, models, written instructions, and other items that are to be used in the demonstration, and this preparation should be checked very carefully to see that nothing is omitted, and that everything is conveniently arranged. Many demonstrations have failed because the teacher neglected to prepare the materials or tools necessary, and at the most crucial point in the demonstration he found that he did not have something that was needed. The class is not slow to recognize the failure of the teacher.

4. *A single fundamental procedure only should be given.*[12] The stimulus should be as intense as possible. This is most effectively accomplished when a single fundamental procedure is presented, and mental adjustments must be made in attempting to establish the required muscular coordination.[13]

To teach how to make arrow-heads is a single fundamental procedure, and teaching it along with the rules for placing dimension-lines complicates both. It is far

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[12]Vaughn and Mays, *Content and Methods of the Industrial Arts*, pp. 93-98.

[13]See Chapter XI, p. 238.

better to teach how to make arrow-heads following the satisfactory placement of the lines for dimensions. Each forms a unit of instruction which requires careful and deliberate preparation in order that it may be simply and directly presented.

5. *Correlated and unrelated material should not be brought in while demonstrating a skilled process.* A common tendency of teachers is to bring up an incident or a correlated feature which comes to mind during the course of a demonstration. It is an impulse which is difficult to overcome, but a knowledge of the evils accompanying it should serve to inhibit the tendency to do so.

The teacher who attempts to teach in one demonstration the many variations of the mortise-and-tenon joint with some account of their uses will not be successful. The complexity is too great. The pupil cannot discriminate and single out a definite point to carry over for practice. He cannot follow all the details, becomes confused, and gives up entirely before the demonstration and discussion are over.

6. *Demonstrations should be given at intervals as need arises.* Little good results from demonstrating a process today that will not be used until tomorrow or next week. Often it is inadvisable to demonstrate at the beginning of the period a process that will not be needed until the end of the period. It must be remembered that the greater the lapse of time between the demonstration and its application, the less likely it is that the learner will respond properly. The application should follow the demonstration immediately.

This principle is fundamental, but teachers often

ignore it in giving oral group demonstrations. Indeed, it is impossible, after the first meeting of the class, to assemble the members at a time when the same needs arise for all of them. This is the most serious obstacle to the success of the class demonstration.

Many devices have been used to overcome this irregularity of progress, such as grouping of projects, and supplementary exercises, but none of them makes adequate provision for taking care of the problem of individual differences. The weaker pupils control the progress of the class. Instruction for each individual separately seems necessary, but when it is attempted orally, it is a heavy and almost impossible burden.[14]

7. *The demonstration should be brief.* In general a single unit of instruction should be presented as quickly and directly as possible. It is difficult for all learners to attend to a demonstration for a long period of time. Not over 15 minutes, usually less, should be necessary for its presentation when it has been carefully planned. Should more time be necessary, it is probable that the unit is too large, and should be divided into two lessons. Pupils should proceed promptly to the application of the process demonstrated. Teachers should not let the desire for brevity lead them into making the demonstration a sort of slight-of-hand performance. The general attitude of the class serves as an excellent guide in determining whether the demonstration is being continued longer than necessary.

8. *The skill of the teacher should be an ideal to be followed.* Teach the thing in the way you wish it done

[14]See Chapter XIII, p. 269.

later. If a high quality of workmanship is desired of the class, a high quality of workmanship must be held before them as an ideal worthy of accomplishment. It is the duty of a teacher to present a demonstration skilfully and with ease in order that the learners may be encouraged to acquire the same mastery. Poor work by the instructor will result in poor work by the learners.[15]

9. *If written instruction-sheets are to be used, the instructor should perform all the work of the initial demonstration by following the directions as given in the instruction-sheet.* The teacher should read the instructions through to the class, and then have some member of the class read them while the teacher performs the demonstration step by step as the instructions are read. This will introduce the class to the instruction-sheet, and give them confidence in it as a reliable device for imparting information. This method should be used from the beginning, since ideals of accuracy are most readily established at this time through the instructor's performance.

Most teachers talk too much during a demonstration. The ceaseless talking of a teacher tends to divert the attention of the class from the process which is being demonstrated.

Subsequent demonstrations should be restricted to small groups where all need the same thing. A transition from the whole group to a small group and then to the individual may best be accomplished by having one of the learners of a group perform all the work of the demonstration while directions are read by another.

[15]See Chapter XVII, p. 332.

This establishes confidence in working out jobs without oral instruction.

It will be necessary to follow up and give oral assistance to some of the slower learners while the faster ones will find the instruction-sheets adequate. The slower individuals often will need to reread the instructions while the instructor gives oral assistance in interpreting them. Excellent training is thus given in comprehension through reading. The brighter individuals interpret symbols with little difficulty, and will proceed at their own rate by using instruction-sheets exclusively.[16]

106. The Need for Follow-Up Attention. Because of individual differences, not all learners grasp every phase of the group demonstration even on the first day when all members of the class are eager to get the instructor's presentation. It will be necessary, therefore, for him to follow up immediately, and observe the attempts of the learners to apply their interpretation of the written instructions as demonstrated by the teacher. They should be taught to rely upon the written instructions rather than upon their recollection of the demonstration. A caution here, a correction there, with a small group gathered together from time to time, will be necessary to put over a point not driven home in the general demonstration. Good teaching of skills requires consistent follow-up of every point presented in the instruction in order to be sure that they were understood.

After the first demonstration the need for individual instruction becomes increasingly apparent as the work

[16]See Chapter XIV, p. 287.

advances because of variations in individual progress. In order to meet this need the instructions should be prepared in permanent form so they will be available at any time.

107. The Instruction-Sheet As an Aid to the Teacher. The well written and well illustrated instruction-sheet is of great value for instruction purposes, but it cannot be depended upon entirely because problems arise in the use of the sheet, as well as in the development of the skills, which require the personal attention of the teacher. Difficulties in reading, imperfections in the instruction-sheets, individual learning habits developed early in life, and the nature of the pupil's learning mechanisms, are all factors which demand the personal attention of the teacher. Printed instructions are not intended to displace the instructor and take the form of correspondence work. Teachers who attempt to use instruction-sheets to relieve themselves of their regular duties fail to understand the problem of learning. The work of the teacher is not lessened by the use of printed instructions, but his efforts become more effective.

108. Summary. It is necessary for the teacher to have a definite teaching plan, but the old formal lesson plan devised for group instruction in academic subjects is not satisfactory. The plan must provide for individual instruction in industrial subjects.

The essential steps in the teaching plan are:

1. *The teacher must provide a situation in which there will be desire or readiness to learn.*

2. *The teacher must assign jobs or tasks that involve the learning units he wishes to teach, and the assignments must be so clear and definite that the learner will know exactly what is required.*

3. *The student should be required to analyze and plan the job that has been assigned.*

4. *The instructor should give all necessary information and directions, and give a demonstration of any new processes involved, if a demonstration is needed.*

5. *The student should do his work according to his plan.*

6. *The teacher should check results.*

7. *Students should report on the job when completed.*

About the only place for the group demonstration is near the beginning of the course. It is effective then because the members of the class are nearer the same level with respect to the content of the course than they will be at any future time. They all need to know certain fundamental things in order to start their work, and it is a matter of economy to present these things to the entire group at the same time. This initial group meeting may be of great value in establishing ideals and points of view with respect to accuracy and methods of procedure.

As a rule, in giving a demonstration the teacher should follow the instructions step by step as they are read to him. This will emphasize their importance and usefulness.

A successful demonstration requires careful preparation and the greatest possible alertness on the part of the teacher. The following principles should be observed in giving a demonstration:

1. *There should be a clear and definite statement of the objective.*

2. *Every detail of the demonstration should be carefully planned.*

3. *There should be a careful preparation of the instruction material required in the demonstration.*

4. *A single fundamental procedure only should be given.*

5. *Correlated and unrelated material should not brought in while demonstrating a skilled process.*

6. *Demonstrations should be given at intervals as need arises.*

7. *The demonstration should be brief.*

8. *The skill of the teacher should be an ideal to be followed.*

9. *If written instruction-sheets are to be used the instructor should perform all the work of the initial demonstration by following the directions as given in the instruction-sheet.*

109. Observation Problem.

Assignment No. 1: Arrange to observe a class demonstration, and make a written report covering the following points and any other matters of interest concerning the success of the demonstration:

1. What was the size of the class?
2. What was the subject of demonstration?
3. Did the teacher appear to have his demonstration well planned?
4. Did he have all tools, materials, and teaching devices ready and well arranged?
5. Did he stick to his subject?
6. Did he talk too much?
7. Were all the pupils interested at the beginning? Was interest maintained throughout the demonstration? Did you observe any marked inattention or lack of interest? If so, do you have any idea of the probable cause?
8. Did the demonstration deal with a matter for which all members of the class had an immediate need?
9. Did pupils participate in any way?
10. Were written instructions used? If so, did they appear to be successful? How could their use be improved?
11. What was the length of the demonstration? Should it have been shorter or longer?
12. In observing the work of pupils after the demonstration, about what percentage appeared to understand the demonstration so that no further assistance of the teacher was necessary?
13. Did pupils have a definite plan of work?
14. When in difficulty did they consult the instructions, charts, and exhibits, or did they consult the teacher?

Assignment No. 2: Observe a teacher of a shop class, and list the distribution of his time under the

following heads. The observation should cover at least 300 minutes:

1. Time given to class demonstrations.
2. Time given to clearing up details of plans or specifications or altering them.
3. Time given to telling pupils "what to do next."
4. Time given to individual demonstrations.
5. Time given to handling tools and supplies.
6. Time given to correction of errors due to improper planning.
7. List time spent on other activities that do not fall under these headings.
8. Give your suggestions for economizing time in any of these activities.

QUESTIONS—Chapter VII

1. In what respects will a teaching plan for group instruction and individual instruction differ?
2. What is the advantage of having a definite teaching plan?
3. What is the advantage of the student having a definite job plan?
4. Why is it advisable for the teacher to assure himself that the pupil knows how to perform each step of the plan before he starts on the job?
5. What are the essential steps in a teaching plan?
6. Under what conditions is the class demonstration desirable?
7. When are those conditions likely to exist?
8. What are the essential factors in a successful demonstration?

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CHAPTER VIII

Skills and Related Subjects

110. The Elements of Skill. Skill is an essential element in many phases of life. It is not a matter confined wholly to vocational education, as some suppose, but enters into practically every phase of life. There are certain skills required from time to time by most men, and the same laws govern the development of these skills as govern the development of strictly vocational skills. They are just as much a part of his general education as history or science.

Skill is a thoroughly established habit of doing a thing in the most economical way. It must not be confused with accuracy. Accuracy should be the result of skill, but a piece of work may be done with a high degree of accuracy, and yet the processes by which it was done may be laborious, crude, and unskilful. If this view is correct, it is clear that there are two distinct elements in the development of skill. *First,* there is the element of doing the thing in the most economical way. This involves methods of procedure and cannot be left to the discovery or invention of the pupil. It is vain to hope that any pupil will discover more economical methods of doing things than have been discovered by the practiced workers in the craft during the long period of its development. We may be well satisfied if the pupil acquires what is regarded by the most proficient workers in the field as the best method of procedure.[1]

[1]See Chapter XV, p. 307.

This element of skill, then, is definite and exact. We must know the most economical way of doing things, and the instructions should be definite, and cover every essential detail of the process. Careful study by scientific observers may develop more economical methods of procedure, but the beginner should not be encouraged to experiment in this matter.

Doing a thing in the most economical way also involves the element of speed. Speed and accuracy constitute the essence of economy in all production processes, and should never be separated in training for skill.

111. Habit As an Element of Skill. The *second* element involved in skill is "a thoroughly established habit." This habit involves the element of speed as well as manipulative processes, and both are subject to the same laws of learning affecting habit formation. These laws are well established and well known, but not always carefully observed.[2] The four main points, as they affect the development of manipulative skill, may be stated as follows:

1. The individual must have a clear notion of what he is trying to do.
2. The operation must be performed correctly the first time.
3. The individual must give close and discriminating attention to the manipulative process which is to be established as a habit.
4. The operation must be repeated with the least possible variation until the habit is established.

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[2]William James, *Talks to Teachers,* Henry Holt & Co., New York, 1915.

112. A Definite Ideal Toward Which to Work. That the individual must have a clear notion of what he is trying to do simply means that he must have a definite ideal toward which to work. The clearer this conception is in detail the greater the probability of success. This point cannot be overemphasized. Time spent in gaining a complete understanding of just what is required is always well spent. No single factor is so conducive to bad habits as the indecision and tinkering that come from a lack of such understanding. It develops a habit of indolence and lack of spirit in the work, as well as habits of incorrect procedure.[3]

The operation must be performed correctly the first time. This is very important. It helps to clear up any obscurity as to the details of the requirements and gives a start in the direction of the right practice rather than the wrong one. To leave to the student the discovery of the best method of performing an operation is not only a waste of time, but it violates the fundamental laws of habit formation. If the teacher does not know what is regarded as the best practice, he should not attempt to teach. If he does know, he should keep this ideal before the pupil, and insist that he strive to conform to it. This means more than mere doing on the part of a pupil. It is the conscious striving for an ideal.

113. Two Elements Involved in the Ideal. It must be remembered that there are two elements represented in the ideal. One is the manipulative skill involved in performing the required mechanical operations; the other is the speed, confidence, and feeling of

[3]See Chapter XVI, p. 319.

mastery with which it is done. Here is one of the great stumbling-blocks for teachers engaged in training pupils in matters involving skill. The general practice is to emphasize accuracy in the mechanical product, and neglect the element of speed. Those who advocate this plan hold that speed, which is one of the elements of good workmanship, may be developed later. The theory is based upon that law of habit formation that states "that the operation must be performed correctly the first time, and that it must be repeated with the least possible variation until the habit is thoroughly established."

The law is correctly stated, but there are two important errors in its application. In the first place, we give too much emphasis to the mechanically perfect product, and thus violate another law of habit formation, namely, that "the individual must give close and discriminating attention *to the manipulative process which is to be established as a habit.*" Attention directed to the production of a mechanically perfect product tends to distract attention from the *habit* we wish to establish.

Every teacher knows that the beginner may often produce a better product by departing from "good form" than by adhering to it. This is particularly true when the time element is not considered. The teacher knows, however, that if the pupil is to develop into an efficient and skilled mechanic he must develop "good form" in doing things, even though the standard of perfection in the product may be sacrificed in the beginning. In some of our shopwork, in which the product has been emphasized, and in which the purpose

has not been the development of skilled workmen, many practices have grown up that do not conform to the best practices of the trade.

The other fundamental error in this notion is that we overlook the fact that speed, decision, and confidence constitute an important part of the habit we wish to form. If we form the habit of doing a thing slowly, it is necessary for us to break down the habit later, and it is very difficult to break down a habit of slothful indolence and establish a habit of speed and alertness. When one moves slowly in a process, attention is likely to be diverted from the ideal of good workmanship to incidental and unimportant matters. Many of the bad manipulative habits in the school shop and drawing-room are the direct result of a lack of emphasis on speed in performance. The boy who pushes his plane back and forth over a board while his attention is fixed on what some other boy is doing is an example of this.

One of the most effective ways of securing attention is to demand speed. When one reaches the point in fatigue where he cannot give undivided attention to his work, or when he wavers in muscular control, he should rest. Intensive work periods with frequent rests give better results in establishing good habits than long periods of leisurely indifference. The teacher must never yield in his demand for both speed and accuracy. They are essential elements in skill, and to neglect either is to permit the development of a bad habit. It is improbable that the pupil will approach either phase of the ideal at the beginning, but the standards should be constantly before him. Every experiment indicates

that accuracy and efficiency in manipulative processes are developed more economically when we insist upon speed than when we do not.

There is also the fear that if we insist upon speed, the pupil will not be able to perform the operation correctly the first time, and will develop bad habits with respect to manipulative processes. This fear is without foundation, if the ideal has been thoroughly established and the emphasis is rightly distributed. Going through the process slowly the first time in order that the pupil may surely understand exactly what is required is justified, but as soon as the ideal is established and he knows exactly what is required speed should be emphasized. The fear arises through overlooking one of the very well understood laws of habit formation.

We do not establish a habit of doing a thing until we get some satisfaction from doing it. If we get satisfaction from a low standard of performance, our ideal with respect to skill will be low. When a teacher gives the satisfaction of his approval to workmanship inferior in either time or quality, he is encouraging low standards. There is no danger of the pupil forming bad habits, even if the accuracy of his work is of a low standard, if he is required to compare it with the established standards. It must be remembered that it is not a question of whether we choose between good manipulative work and speed, as some suppose, but it is a question of whether we give due regard to all the elements involved in skill.[4]

[4]See Chapter XI, p. 238.

114. Best Results Obtained When Both Speed and Accuracy Are Emphasized at Same Time. In order to secure both speed and proper technic in the development of skill, the teacher should first establish a definite ideal. This is the standard which the boy must seek to attain, and if he falls below it he will not receive full approval. Having thoroughly established an ideal with respect to the manipulative processes, the next step is to insist upon speed in performing them. In all probability the results from the first few attempts at speed will be much less satisfactory mechanically than they would be if more time were allowed, but in the end the results will be more satisfactory. Best results will be obtained when both phases of the habit are developed at the same time.

115. Discriminating Attention Necessary. The individual must give close and discriminating attention to the manipulative process which he is to establish as a habit in order to avoid any deviation from the ideal. In this way he will get the feel of the process when correctly done, which is an important factor in establishing the habit. Attention must not be diverted to other matters.

The process must be repeated with the least possible variation until it is easier to conform than it is to vary. James says, "Never permit an exception to occur until the habit is securely rooted in your life." If a pupil is permitted to experiment before the habit is established, exceptions will occur and unsatisfactory habits will develop.

116. Training for Skill Requires a Different Method from That Required for Thought and Reasoning. The

development of a skill and the development of thought and reasoning represent two very distinct phases of training, and require different methods of treatment. In developing skill we undertake to train in practices that have been long established as the most efficient methods of doing things. It is an established standard known to the craft, and there is no more reason to expect the pupil to invent a better method of procedure than there is to expect him to invent the facts of history. The process is definite and exact, and the best way for the boy to get it is through written directions or word of mouth, followed by practice. From the teacher's standpoint it is dictation; a simple statement of fact that the operation should be performed in a certain way. From the pupil's standpoint it is practice in performing it in that way until the habit is firmly fixed. The element of thought and reasoning comes in the application and combination of this skill with other skills to the problems of production. It is not intended to suggest that the skill should be taught as unrelated to its practical application, but it is intended to emphasize the character of training required for the development of skill, and how it differs from that required for the development of reasoning and planning.[5]

117. Planning Develops Thought and Skill. Trade and industrial work give unusual opportunities for the practice necessary in developing thought and reasoning. It has the additional advantage of being done in a practical situation similar to that encountered in real life, and therefore eliminates, to a large degree, the

[5]See Chapter XV, p. 307.

question of transfer of training. It has been pointed out that skill is not a matter of thought or discovery, but a matter of conforming to the best established practices. Many teachers, in their anxiety to develop what they regard as the higher forms of learning, have left to the pupils the discovery of skills in the hope that they would reason out the best method of procedure. They saw no other opportunity for teaching reasoning in the shop. They did not realize that every job presents a problem of method of procedure, and that every job must have a different plan of procedure. The ability to plan his work is one of the most valuable assets a man can have without respect to his vocation. It involves the highest type of reasoning.

118. Related Subjects. In addition to skills there are a great many other things related to the trades, which one should know if he is to be successful in that vocation. These things usually have been grouped under such headings as "Related Subjects," "Related Information," or "Trade Practice." The term "Related Subjects" is rather unsatisfactory because it has directed attention to *subjects,* as at present organized in schools, rather than to the particular *things* to be taught.

Whatever the terms used they represent a type of work requiring different methods of procedure in teaching from that required in developing skills. There is no reason, however, why the shop teachers cannot be trained in these methods as well as in the methods of developing skills, and thus unify the instruction, keep all phases of it more closely related, and get better results than when different teachers are used.

Departmentalizing elementary trade instruction is a questionable practice.

It is necessary for the teacher to know in what specific skills the pupil should be trained, what scientific principles he should understand, what facts and general information he should have at his command, and the usual trade practices with which he should be familiar. He should know, also, the most effective methods of presenting the learning units in each of these phases of work. With such a program clearly set forth, the amount of time to be devoted to each phase of the training may be readily determined, and the work carried forward with the greatest economy of time and energy.

Convenience in administration has led to the practice of requiring that a certain percentage of the time be devoted to so-called "Related Subjects" in trade teaching. This has been done in order to prevent overemphasis of the shopwork by some teachers, and underemphasis of shopwork by other teachers. While the purpose of this rule is good it has not been satisfactory in practice. It is perfectly obvious that the amount of time required to learn the scientific principles and the practices involved in the successful practice of certain trades is quite different from that involved in the practice of other trades. The amount of time required for the related matter for the printer or electrician is much greater than that required for the automechanic or the bricklayer.

In the industrial arts such units of instruction are not related to any particular trade, but include all that field of information and knowledge that is directly

related to or motivated by the work in the shop. The same principles of teaching apply in either case, and the methods vary in minor details only.

119. Difficulties in Teaching Related Subjects. Many difficulties are encountered in teaching such material. Some of them arise out of the variation in the abilities of the individuals, their unequal advancement, and previous experiences. Another group of difficulties arises out of the character of the material, the attempt to use the old formal organization of subject-matter, the want of a proper analysis of the situation, and an attempt to apply theories of teaching where they are not applicable, or in a manner that is not effective.

Every teacher, whatever his subject, recognizes the the wide range of individual differences, and in no kind of work is it more readily discernible than in industrial work. There appears to be a popular notion that individual instruction may be necessary in shopwork where differences in the progress of pupils are so easily observed, but that it is not necessary in other phases of training. As a matter of fact, variations in the progress of pupils in other subjects are just as great as in shopwork, but we are better able to measure the degree of progress of work in the shop by an objective examination of the work accomplished. We have great difficulty, however, in measuring accurately the progress of individuals in academic subjects and, even when measured, teachers often appear to be unable to grasp the significance of the variations in the accomplishments of individuals in an academic group.

The unequal advancement and previous experiences of pupils must be an important factor in our teaching

plans. The fact that a group of pupils has completed the same grade in our public schools does not assure us that they are even approximately of the same degree of advancement. Throughout their school career they have been advanced with a group and without respect to equality of attainment. The matter of outside experience and maturity also constitutes an important factor. Irregularity of attendance and variation as to the time of entrance both have an important influence upon the attainment or progress of the pupil. All of these factors contribute toward making individual instruction necessary.

120. Individual Instruction Necessary. Individual instruction is necessary for any satisfactory solution of the problem, but individual oral instruction is very expensive, impracticable, and in many respects inefficient. A teacher who relies upon individual oral instruction can handle only a small number of pupils, and the cost is out of all proportion to the value of the instruction as compared with other plans. Even with a very small group it is impossible to give instruction just when it is needed and just to the extent needed. When a student is absorbed in a particular task, he is at that time interested only in the instructions that will enable him to perform that particular task, and oral instructions in excess of that are quickly forgotten even though they are individual instructions. In the case of oral instructions we must rely upon the memory of the pupil to retain them until they are needed. This memory is aided by immediate use, but we cannot always take advantage of this factor by giving immediate application to all facts presented. We are notori-

ously inaccurate, diffuse, and verbose in our oral instructions, and pupils are even more inaccurate in their understanding and recollection of our instructions. For these reasons it appears to be unwise to rely to any considerable degree upon individual oral instruction.

121. Written Instructions the Best Solution. In order to meet the requirements of the situation some system of individual instruction must be devised to overcome objectionable features of oral instruction. The written instruction-sheet appears to offer the most satisfactory solution to the problem, and when carefully prepared serves the purpose admirably.

One of the most important steps in securing good work from a pupil, or from anybody else for that matter, is to assign him a task with specifications so definite that there can be no doubt about what is required. Indefinite and inexact assignments are the most prolific causes of failure, both in school and out of school.

When an individual is given accurate and exact assignments he not only knows what is required, but he knows he can be checked up on every detail. He realizes that certain responsibilities are fixed upon him, and he is much more likely to try to live up to them than he would be if the assignments are indefinite as to their requirements. In this respect the written assignment has a very distinct advantage over the oral assignment. In making a written assignment we are much more likely to be accurate and complete than when it is made orally. The written assignment carries with it the feeling of much greater exactness, and the pupil has no occasion to rely on his memory or

some hastily written notes. Under such circumstances the pupil not only feels constrained to do more exact work, but he derives greater satisfaction from doing it.

We all have felt the exasperation that comes from the assignment of a task the requirements of which are indefinite, and yet we know that we will be expected to conform to the unrevealed requirements in the mind of the one who made the assignment. The written instruction-sheet is an admirable means of correcting this difficulty in instruction, and this part of the instruction-sheet must be handled with the greatest care. Perhaps the most satisfactory type of instruction-sheet for use in teaching related subject-matter is what is called the "Assignment-Sheet." The form of this sheet varies with the type of school and the subject-matter treated. An Assignment-Sheet dealing with arithmetical processes would differ in some details from one dealing with the investigation of an industrial plant or process, types of which are shown in Chapter III.

In the beginning the assignments should be very definitely outlined. Undoubtedly many teachers maintain that the pupil should be required to make an outline for his study or investigation, but long experience has shown that in the beginning it is wiser to teach the pupil the use of tools rather than to teach him how to make them. In this and similar cases, after the pupil has used an outline, he will be more easily convinced of its importance and value. It is better to avoid introducing too many elements into one problem, even if there is a logical connection. The matter of

teaching a student how to develop his outline may come later, after he is familiar with its characteristics and use.

In the preparation of assignment-sheets for the study of industrial plants there may be considerable variation in the points about which information is desired. The source of information and the method of securing it may vary also. The directions should call the pupil's attention to any available reading matter dealing with the subject, and he should read this before making inspection.

122. Sample Assignment-Sheet in Arithmetic. In the Assignment-Sheet[6] for arithmetic and science there should be a definite statement of the assignment, a careful and exact statement of the principles involved, or the rules to be followed, together with an adequate explanation and examples of their application. These should be followed by a series of problems involving the application of the principles.

ASSIGNMENT SHEET—*Arithmetic*

Assignment: To multiply together numbers when one or both of the numbers contain a decimal.

How It Is Done: Proceed to multiply as in multiplication of whole numbers, and point off as many decimal places in the product, counting from the right, as there are places in the multiplier and multiplicand. If there are not as many places in the product prefix ciphers until there are.

Examples:

(1)	(2)	(3)	(4)	(5)
.3	.12	.042	.6	.14
2	3	3	.2	.3
.6	.36	.126	.12	.042

[6] R. W. Selvidge, *Individual Instruction Sheets,* The Manual Arts Press, 1926, pp. 53-58.

(6)	(7)	(8)	(9)	(10)
.06	3.18	1.05	2.5	.0006
.04	5	.04	1.6	.003
.0024	15.90	.0420	150	.0000018
			25	
			4.00	

By counting the number of decimal places in the multiplier and multiplicand of each example it will be found that there are exactly the same number of places in the product.

When the multiplication was completed in examples five and six there were not as many figures in the product as there were decimal places in the multiplier and multiplicand, and it was necessary to prefix ciphers to give the required number of places.

If you remember that there always must be as many decimal places in the product as there are decimal places in the multiplier and multiplicand, you will have no trouble in the multiplication of decimals.

Your Job: (1) In the following examples count the decimal places in the multiplier and multiplicand, and see if the decimal point is properly placed in the product:

60	.07	.0027	6.21	3.42
.8	8	.02	.14	2.5
.480	.56	.000054	2484	1710
			621	684
			.8694	8.550

The following problems should be solved on your work-sheet, and turned in to your teacher with this assignment-sheet.

(2) Complete the multiplication in each of the following problems, and place the decimal point in its proper place:

3.65	.124	.004	68.4	1.21
.24	.003	.002	.26	5

Check your work by adding these products. The sum of all the products should be 24.710380.

(3) If an apprentice receives 29 cents an hour, how much will he receive per week if he works eight hours a day for six days?

(4) If one brick weighs 7.26 pounds, what will a load of 825 bricks weigh?

(5) The circumference of a circle is found by multiplying the diameter by 3.1416. What is the circumference of a pipe the diameter of which is 6.5 inches?

Problems like these, requiring applications of the rule, may be continued as far as desired; but, in general, it is advisable to give only a few general problems on this sheet. It may then be used for all groups, and sheets of supplementary problems should be provided dealing with the particular phase of work in which the pupil is engaged. There is a distinct advantage in taking the supplementary problems from the type of industrial work in which the pupil is interested.

123. Sample Assignment-Sheet in English. Corrective work in English is easily handled by the use of the assignment-sheet. There are a number of errors so common that sheets should be prepared dealing with them, and when the error occurs the pupil should be given the assignment to enable him to overcome this particular bad habit of speech. A very common error is in the use of the forms of the verb *see*. The following assignment-sheet illustrates a method of handling this particular error:

ASSIGNMENT SHEET—*English*

Assignment: To learn to use correctly the words, *see, saw,* and *have seen.*

How to do it: Saw is always used alone, and *seen* is always used with a helping verb such as *have* or *is.* Watch your speech in order to be sure you follow this rule. The best way to correct an error in the use of English is to use the correct form so many times that you become accustomed to it, and then watch your speech to see that you do not fall into the old habit. *You* are the only one who can cure this defect in your use of English.

In the following sentences the words are used correctly:

I *saw* you at church Sunday.
I *have seen* three robins today.
He *saw* the parade.
We *have* not *seen* him this week.

They *saw* the new moon through the trees.
They *have seen* better days.
I *saw* you at school today.
I *have seen* you at school every day this week.
We *saw* a big fire this morning.
I *saw* an uncle today I *had* not *seen* for years.
Have you *seen* our new automobile?
You should *have seen* it.

Your Job: On the attached sheet you will find a number of sentences with blank spaces in them. Fill in each space with the correct word.

Examples might be multiplied, but the variations would be in form and not in principle. The essential thing is to assign a definite task, make available all necessary information and material for performing it, and then place the responsibility on the pupil. If practice or drill is involved, this must be provided for in the assignment.

124. Care in Selecting Topics. The preparation of instruction material in this form requires the greatest care in both the selection of the material and in the method of handling it. In the first place, we should select the more important items in which the pupil may require instruction. These should be selected without respect to the ordinary conventional division into subjects. A pupil is not interested in learning a thing because it is listed under the head of physics, but because it helps him in the performance of a task. Pupils are much more interested in the facts of life and the laws of nature when they are related to the work they must do than when they are placed in some logical, artificial grouping as a school subject. It is better, therefore, to select the units of instruction on the basis of the pupil's work and needs than with a

view of presenting the material gathered together in the ordinary text-book. In considering the problem of the distribution of a load with respect to its supports the pupil is not interested in whether it is arithmetic, physics, mechanics, or graphic statics.

In the matter of presenting the units of instruction the direction of emphasis is important. Herein lies the chief difference between the work for the part-time school or trade school, and the manual-arts work. For the boy or girl in the part-time school or trade school, the period of formal educational training probably will be short. For such pupils it is far more important that they know a principle or law, and have opportunity to apply it, or see it applied, in a great many situations, than it is to know why it is true. It is more important for them to know how a thing acts under certain conditions than why it acts so.

Scientific theories often are quite beyond the comprehension of these young people and if understood would be of little practical value. For example, it is far more important for a prospective mechanic to know that heat will cause metal to expand, within certain limits, and that this is a very powerful force which must be taken into account in work where metals will be subjected to considerable heat, than it is to know the theories of molecular structure. It is more important for the steam-fitter to know that the pipe will expand when heated by the steam, and how to make provision for this expansion, than it is that he should understand the theories of heat.

In the case of the manual-arts pupil the chances are that he will continue in formal school training for a

somewhat longer period, and will have greater opportunity and more occasion to inquire into the why of things, and less reason to know the how of things. It is just this theoretical side of training, however, that leads to the criticism of schools as being impractical. Perhaps we should have both, but the time limit for the part-time or trade pupil makes it impossible to give any considerable amount of training in both the theory and the application, and when it comes to a choice between the two the practical should be favored for this group. In the manual-arts group both phases may receive attention.

125. Written Instructions Not a Labor-Saving Device for the Teacher. Instruction-sheets will not reduce the work of the teacher, but they will make his work more effective. They are in no sense a substitute for other teaching devices and materials, but are a means of making such materials and devices more effective. They make possible the instruction of any pupil at any time he needs the instruction, and a genuine relation can be established between the subject-matter and the practical job. The assignment-sheet may be used with equal facility in the shopwork in connection with a job, or in the classroom. In part-time work, where the entrance and attendance are both irregular, assignments may be made promptly and without loss of time to the pupil. He may be kept busy on worthy work at all times. Delays in assignments are fruitful causes of dissatisfaction and disorder. This method of assignment also makes it a simple matter to keep an accurate record of the pupil's progress.

126. Observation Problem.

Assignment: Go into the classroom where instruction is being given in related subjects; observe the work, and make a written report covering the following questions:

1. Were all members of the group interested in the same subject?
2. Was the subject of instruction connected with a particular job in which the pupils were interested, or was it just a matter of general interest to the trade?
3. Was the instruction on an individual basis or group basis?
4. Were all members of the group interested and attentive?
5. Have you any suggestions for improvement?

QUESTIONS–CHAPTER VIII

1. What is skill?
2. What are the laws of habit formation?
3. What is the relation of accuracy and speed in skill?
4. What are the essential differences between the methods of training for skill and those for thought and reasoning?
5. Should we expect pupils to discover the skills we wish them to learn? Why?
6. Why should pupils be required to plan their jobs?
7. Why is departmentalizing trade instruction a questionable practice?
8. What difficulties are involved in setting aside the same percentage of the time for related-subject work in all trades?
9. What are the principal difficulties in teaching related subjects?
10. What are the most effective means of handling these difficulties?
11. What are the principal characteristics of instruction-sheets used for this purpose?

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CHAPTER IX

Cooperative Part-Time Teaching

127. Cooperating Agencies Must Recognize Mutual Responsibilities. The principles of teaching involved in cooperative part-time training do not differ from those involved in any other kind of teaching. The differences lie in the selection of the material to be taught, and in the methods involved in the presentation, due to the facts that there is a joint responsibility, and that there is a shorter period of time for school instruction.

Both of the cooperating agencies should recognize the responsibility involved in the introduction of a cooperative training program. It must be recognized by both that there is a division of responsibility, and that neither can carry out adequately its part of the program independently of the other. Each must have its own particular part of the task to perform in order to attain the desired end. We must never lose sight of the fact that the purpose is education and training, in so far as the cooperative activity is concerned.

Of course, it is clearly understood that the employer is giving employment to the youth because his labor is profitable, and not for the primary purpose of training and educating him; but this is not a part of the cooperative program. It is of fundamental importance that each of the cooperating agencies knows in detail the things it is to do as its part of the task, and feels a keen responsibility for doing it. A merely tolerant attitude is not sufficient.

When this mutual responsibility is recognized cooperative training provides a very effective method of giving vocational instruction. The plan, however, is just as susceptible to abuse and to improper handling as any other scheme of training. The industry is likely to place upon the school the responsibility for all systematic instruction, and the school is likely to be so interested in the opportunity that a cooperative arrangement offers for the pupil to come in contact with actual industrial situations that the necesary precautions in carrying on the work will be neglected. Because of the eagerness to have the pupils participate in actual industrial processes, the school often fails to make adequate provision for protecting their interests.

128. Opinions of Employer Not an Adequate Guide for Training. We are likely to accept almost without question the suggestions of the employer as to what cooperative pupils should be taught in the school, but such suggestions should be analyzed and weighed carefully. Not many employers have given thought to the broader aspects of training. It is only an incident in their business, and their suggestions are usually stated in the most general terms, or consist of some minor details in which they have found employees deficient. Not many employers have taken the time to examine into the real causes or the extent of the deficiencies of the workers. Frequently they do not understand that it would be unwise and practically impossible for the schools to undertake to train workers for a specific task. There is no assurance that the worker would be able to obtain employment in a particular job even if he were trained for it. The failure of the employer

to recognize this situation has led to many of the criticisms of school training.

We may well look to the employer to tell us what he wants the employees to know, but it is the business of the schools to determine what particular training will enable the employee to do it. This does not mean that the two agencies should act independently. On the contrary, there should be the greatest possible cooperation between the teacher and the representative of industry in the selection of material which each is to teach. When this is done, the school may be relied upon to carry out its part of the program in a very satisfactory manner. The chief difficulty of the school has not been in its methods of teaching, as some suppose, but in securing material that has direct relation to the situations involved. Much of the mystery is taken out of teaching when the teacher knows exactly what he is to teach, and the pupil knows exactly what he is to learn. This is true not only in the school but of the training in the industry.

129. Some Difficulties of the Program. The most serious defect in the entire program is in the lack of good and systematic training in the industry. Apparently there is a sort of unconscious feeling on the part of the employer that the school has the responsibility for training, and he does not recognize his own specific responsibility in this matter even when he undertakes a cooperative program. This is not surprising, since training is the primary function of the school, and is regarded only as an incidental matter in industry.

One of our difficulties lies in the fact that we have not realized that a large part of the instruction must

be given outside the schoolroom. In general, the place to learn the technic of the occupation is in the occupation. This means that the youth must be taught systematically in the shop as well as in the schoolroom. He is entitled to just as careful and thorough instruction in the technic of his vocation as he is in reading or in arithmetic.

It does not follow that there must be someone in the industrial organization called a teacher, but the industrial organization must assume the responsibility for teaching the youth certain definite things, and must make adequate provision for this. To get an industry or a labor organization to assume such a definite educational obligation, and to make adequate provision for carrying it out, is one of the most difficult tasks that confronts the promoter of cooperative training.

130. How to Protect the Interests of Cooperative Pupils. In order to protect the interests of cooperative pupils every agreement should contain two detailed lists of the things the pupils are to be taught. One of these lists should contain the things the school will teach, and the other should contain the things the industry will teach. These lists should be placed side by side, and each checked against the other, and so arranged that there may be the greatest possible correlation between the work taught in the school and the work taught in the industry. Even with the best possible arrangement the correlation often is very slight. These lists should be arranged in groups so as to provide a checking point every two or three months, and at a definite time it should be determined whether each of the cooperative agencies has performed its

function properly during the period, and has taught the things it set out to teach. It may be difficult to work out such lists, and to fix the responsibility as definitely as suggested, but unless it is done the work in the school is likely to be academic and the work in the industry only a part-time job instead of a cooperative training scheme.

131. Employer Must Have a Training Schedule. In order to carry out a training program effectively the employer should arrange a training schedule just as carefully as he arranges his production schedule; and it should be adhered to with as great exactness, and checked for results with as much care as he checks his production. If this is done the work of the employee will be of so much higher a grade, and he will be brought into maximum production in so much shorter a time, that the additional cost of systematic instruction will be more than paid for by increased production. It must be remembered that a cooperative training program involves mutual responsibility, and that these responsibilities should be definitely fixed in order that each may carry out his part of the program and know exactly what the other is doing.

132. Division of Time Between School and Industry. A careful and detailed statement of the specific things in which the pupil is to be trained, both in the school and in the industry, provides a good basis for the distribution of time as between the two phases of training. An equal division of time between school and industry is the generally accepted scheme, but a very careful investigation fails to indicate any adequate reason, other than administrative convenience, for such a di-

vision. Indeed, it appears unreasonable to assume that an equal division of time between the two phases of training is an economical arrangement. There has been no adequate investigation of this question, but it is probable that efficient instruction requires that the division of the time should vary with different types of work, and that in fields in which manipulative skill is important, and technical information relatively unimportant, a smaller proportion of time should be given to school, while a larger proportion of time should be given to school when the amount of technical information is relatively large.

A carefully prepared analysis of some of the vocations in which cooperative training appears to be feasible for a list of the learning units which can best be taught in school and those which can best be taught in industry would be of great value. It is probable that one interesting development of such an undertaking would be the discovery that there are a considerable number of the more intricate, highly skilled, and rather infrequently used operations of the trade that the industry will not accept the responsibility for teaching. As a matter of fact, the industry, under ordinary conditions, does not offer to the apprentice an opportunity for this kind of training. In general, such things must be taught as practice work in the schools, or learned only after years of work in the trade.

133. The Part-Time Continuation School. The part-time continuation school presents one of the most difficult problems, from the standpoint of class instruction, with which our schools are confronted. The short

time per week for instruction; the large proportion of the total instruction time lost by a single absence; the unequal advancement of pupils at time of entrance; the wide variations in ability, employment, and interest; all combine to make group instruction extremely difficult and unsatisfactory. In no phase of school work is individual instruction more necessary or more important. In order to do this it will be necessary to use written assignments and instructions to a large extent. To many this may not appear to be feasible because many of the pupils lack adequate training in reading. While this is true the same objection applies to the use of texts or any other printed material. The use of printed assignments and instructions presents a most compelling motive for learning to read, and possibly learning to read so as to get information from the printed page is one of the important things we can teach the part-time pupil.

There is another point concerning the training of these children which the person who has not taught them does not realize. They have been accustomed to having definite tasks assigned them in industry which they are expected to do, and this has established a rather definite attitude toward tasks that are assigned. If the teacher can make very definite assignment of tasks within the capacity of the pupil, and furnish all necessary instruction and material for performing the task, the pupil will work at it just as faithfully as he will a task in the shop, and with just as good a prospect of success.

134. Summary. If cooperative training is to be effective, each of the cooperative agencies must have

clearly defined responsibilities for training, and each must be held to strict accountability for the work within its field. It will add greatly to the effectiveness of the program if the pupil and public know the definite responsibility assumed by each, and can place side by side the lists of things they each propose to teach.

Individual instruction is necessary in the part-time continuation school, and the best method of giving this is through the use of the written instruction-sheet.

QUESTIONS—CHAPTER IX

1. What should be the basis of the division of responsibility between the school and industry?
2. How can the responsibility be fixed?
3. What are the advantages of a public assumption of definite responsibilities?
4. What are the advantages or disadvantages of a comparison of progress?
5. What should be the basis of the divsion of time between the school and industry?
6. What are the principal difficulties of instruction involved in the part-time general continuation school?

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CHAPTER X

How We Learn

135. The Influence of Heredity. The ability to learn is one of the distinguishing characteristics of the higher forms of animal life. It has its physical basis in the nervous system, and finds its highest manifestation in man. There are wide variations in this ability as among groups, and among individuals of a group, due to inherited characteristics. We expect children to show decided outward physical resemblances to their parents, or to some ancestor, and we are justified in assuming similar resemblances in other characteristics which affect more directly the life and activity of the individual. We inherit not only outward physical characteristics, but characteristics of the nervous system, glands, and other inner organs of the human body which have a controlling influence on the learning behavior of the individual who possesses them.

A continuity of parental characteristics takes place through determiners in the germ-cells of reproduction which are the carriers of the heritage from generation to generation. Characteristics dominant in one individual may combine with characteristics of another and be passed on through the agency of determiners in the germ-cell, and eventually form a new organism possessing all or a part of the potentialities of the parent organisms. Each germ-cell possesses an identity of its own; it possesses the fixed hereditary mental and physical possibilities of the future organism. It is not understood how this is effected. Experimental evi-

dence indicates that it may be determined by remote as well as by immediate ancestry. The potentialities of the individual are fixed in the germ-cell, and any further development must come after birth, through the influence of environment.[1]

Since all the potentialities of the individual are determined before birth, their importance in relation to learning is obvious. They determine the character of the raw material with which we must work. The born idiot is deficient in one or more of the inner components that enable him to learn. The normal individual inherits all of the components that are necessary to learning. These are included in the kind of nervous system and glands inherited. What an individual may have in the way of abilities, character, and possibility of growth, is held in this inherited nervous system and in these glands. Whatever their nature and fineness, it was determined in previous generations.

136. The Influence of Environment. The effect of environment is recognized in the necessary development of the individual after birth. Heredity sets a limit to the achievement of every individual, and environment conditions the achievement within that limit.[2] Poor heredity cannot be changed by good environment, but poor environment can prevent a good inheritance from reaching the limit of its possibilities. Idiots and imbeciles may be placed in the care of experts, and every possible training and opportunity for study afforded, but they cannot be taught beyond the

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[1]H. E. Walter, *Genetics*, The Macmillan Co., New York, (1913), pp. 3, 4.

[2]Loc. cit.

limit of their inherited capacity. We may apply all we know about overcoming these deficiencies but we cannot overcome them. Persons possessing a high degree of intelligence may never reach their limit because of unsatisfactory environment. An unfortunate environment may lead one to become a high-grade criminal who, under a more favorable environment, might become a scientist. One's potentialities in the field of law may never be realized because of a rural environment. These potentialities will develop under a favorable environment because the nature of the environment controls the ultimate development.

Heredity and environment are equally essential. The inherited nervous system and glands, the presence and characteristics of which determine how, and to what extent, the environment may affect the individual, are not composed of ideas and habits, ready to function, but constitute a mechanism ready to function when power is developed and applied to it. It is a machine containing more intricate and mysteriously functioning parts than any known mechanical apparatus. The efficiency and long life of this mechanism is dependent upon the material from which it is made and the energy that makes it function.

137. The Educational Process. The process of improving the operation of the learning mechanism is called the educational process. Modifications are easily made, and the slightest experience has an influence on the future reactions of the individual. The type of experience one gets determines, to a large extent, the place he will have in his service to society. The development of manual dexterity may enable him to pro-

duce articles of social and personal value and artistic merit, and bring to him the highest satisfaction. Likewise, the development of the musical or mathematical ability may give him the highest satisfaction, because the machine is made to function more smoothly and pleasantly in those lines, and he renders a valuable service to society and incidentally to himself.

The teacher of industrial work cannot increase the native endowment of a deficient child, nor can he secure results from a deficient child equal to those from a normal one, but he must provide an environment through which the pupils may reach the highest state of efficiency that their original nervous equipment will permit. Those who come to us poorly equipped with a nervous mechanism cannot be trained beyond the limits of that mechanism.[3] Those who come highly equipped cannot be brought to their highest development by poor instruction and poor instructional conditions. An understanding of the manner in which the nervous system functions is important in the study of teaching.

138. The Stimulus-Response Theory in Learning. Every movement, thought, impulse, attitude, or emotion, from birth until death, is a reaction to stimuli. The effects of light cause blinking of the eyes; extreme cold causes a desire for warmth; the sound of the motor causes foot action of the clutch; a question from the teacher causes the pupil to answer; and so every form of behavior in our daily existence is caused by stimuli in some form.[4]

[3] A. I. Gates, *Psychology for Students of Education,* The Macmillan Co., New York, 1924, p. 116.

[4] E. L. Thorndike, *Psychology,* Vol. 1, Teachers College, Columbia University, New York, 1913, Chapter 13.

A stimulus is anything that will arouse a response, or reaction. A stimulus may be external, or come from without; or it may be internal, and come from within the individual. The external stimuli may appear in a multitude of forms, such as sound, light, vibration, pain, or objects. Internal stimuli consist of changes within the individual that arouse such responses as hunger, thirst, fatigue, emotions, meditation, or illness in various forms. Every kind of reaction is a response to some kind of stimulus.

This theory applies to all organisms, but for our purpose as teachers, we shall be concerned only with its function in the learning process in man. There are special organs through which stimuli are received, and special organs through which responses are made. The organs that receive the stimuli are called the receiving mechanisms; the organs that respond are called the reacting mechanisms. It is apparent that a connection must be made between the receiving mechanisms and the reacting mechanisms. This connection is called the connecting mechanism; it is the nervous system.

In the receiving mechanisms, also called the sensory apparatus or sensory organs, there are millions of receptors that receive the stimuli. These receptors connect with the ends of nerves, and every stimulus initiates an impulse that is carried by the nerves, as part of the connecting mechanisms, to nerve centers which may be called switching stations in the spinal cord or the brain. From the switching station the impulse is carried by other nerves to the organs of response. This event is called a *stimulus-connection-response* unit, and is the basis for the *stimulus-response* theory.

139. No Inborn Faculties. A further description of the mechanism will be of value in clarifying the stimulus-response theory in the light of physiology. Behavior can be determined only by the physiological organism, and not by some mysterious inborn faculties. The ability to make adjustments to changing conditions, or to learn, lies in the adaptive possibilities of the nervous, muscular, and glandular systems. These systems are peculiar to animal life; plants are devoid of them, and therefore cannot make adjustments. The glandular system, not as yet fully understood, is said to condition the nervous and muscular systems.[5] The fact that these systems are adaptive, points the way for education. What environment and training can do for an individual depends upon the condition of these systems.

140. The Neurones. The nervous system is composed of millions of neurones, microscopic in size. Referring to Fig. 7, the essential parts of a neurone are: (*a*) the axones, or fine fibers; (*b*) cell bodies; and (*c*) dendrites, or fine branches. The axones and dendrites are really branches from the cell body. The spinal cord is a cable of neurones, and the brain is a mass of them. An impulse, passing from the receiving mechanism to the reacting mechanism, must pass from the sense organ (*x*) through the axon of the sensory neurones over a space called the synapse (*D*) into the dendrites (*c*), through a cell body (*b*), and through an axon of the motor neurones (*b*), to the muscle (*y*), or other reacting mechanism.

The nervous system is so highly organized that an

[5] A. I. Gates, op. cit., pages 68-71.

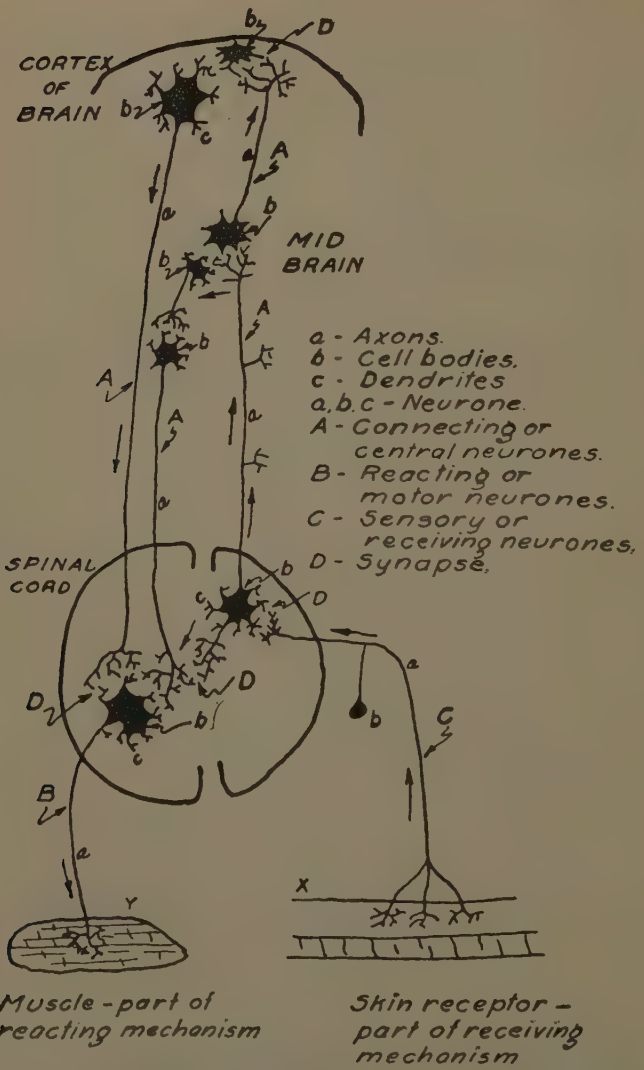
CORTEX OF BRAIN
MID BRAIN
SPINAL CORD
a - Axons.
b - Cell bodies.
c - Dendrites
a,b,c - Neurone.
A - Connecting or central neurones.
B - Reacting or motor neurones.
C - Sensory or receiving neurones.
D - Synapse.
Muscle - part of reacting mechanism
Skin receptor - part of receiving mechanism

FIG. 7. Diagram to illustrate the construction of the human nervous system.

impulse initiated at one point of reception may go to any or all parts of the reacting mechanisms. The arrows in Fig. 7 show the possible directions of an impulse. It may pass directly through the spinal cord, or through the mid brain, or through the cortex, or through all of them, depending upon the nature of the stimulus. These impulses, analogous to electric currents, are passing through the body continuously in a network of directions as in a telephone system, first here, then there; or to a number of reactors at once, always causing the body to react, or to perform the acts of daily existence.

141. Three Classes of Neurones. There are three classes of neurones: (1) Those that receive the stimulus from a sense organ and convey it inward are called sensory neurones; (2) Those that receive the stimulus indirectly from sense organs and conduct it to the muscles, or other organs of response, are called motor neurones; (3) Those that connect the sensory neurones with the motor neurones are called the connecting neurones. The sensory neurones can only receive and convey inwardly the incoming stimuli, and the motor neurones can only pick up and convey to response organs the stimuli that come from the sensory neurones. The process is never reversed, although there are millions of potential connections from sensory to motor neurones.

The connecting neurones are in the spinal cord and brain, and they are called the central nervous system, Fig. 8. There is an enlargement at the top of the spinal cord, called the medulla. Above the medulla is a larger mass of neurones which is divided into two hemi-

spheres called the cerebrum. At the back, and below the cerebrum, is another mass called the cerebellum. The cerebrum is incased in an outer structure known as the cortex. It is really a mass of cell bodies of neurones, and the most intricate connections of the central nervous system are made there. It controls the higher thought processes. Consciousness, or the state of being aware, has its existence through the influence of the cortex.

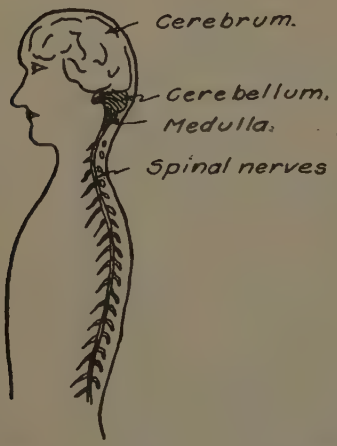

FIG. 8. Diagram to illustrate the central nervous system.

142. The Synapse. The synapse, Fig. 7, (*d*), is a place, or space, between the axon endings and the dendrites through which the impulses must pass. These endings do not touch, but come into extremely close proximity. The synapses vary in the degree of ease with which an impulse may cross; the resistance in some is very low, in others it is very high. The impulse always passes from axon to dendrites, and never in the opposite direction. It crosses only where the resistance is low enough for the existing impulse. The strength of the impulse and conditions due to inheritance are important in determining whether it will cross.

143. Heredity and Repetition Are Factors. Heredity and repetition are said to be responsible for the degree

of difficulty, or ease, with which impulses may pass over the synapse.[6] In some people it is difficult, and in others it is relatively easy for impulses to pass the synaptic connections; that is, learning is more difficult for some people than for others.

Repetition, in turn, will increase, and lack of it will decrease, the possibilities for impulses to travel over the synapses. Repetition of responses will build up preferred routes over the synapses through which little resistance is offered for similar recurring impulses. For instance, the learning of words, or the development of skills is attained in proportion to: (1) the synaptic connections for learning made possible through heredity, and (2) the strength and repetition of the impulses that are needed to build preferred routes. A stimulus, the layout for a mortise, prompts a reaction to cut it, but unless the pupil has learned to cut a mortise, the desired reaction cannot take place. Sometime, and somewhere, in his nervous mechanism he will need to have built up preferred routes through which the impulse from the stimulus of a mortise-to-be-cut will readily pass to the reacting mechanism necessary in cutting it. He needs to have learned how to cut a mortise before he can cut it successfully when it is needed.

Learning, which persists throughout life, is a continuous process of building preferred routes and forming new combinations of old ones—not a few, but millions of them. The greater the network of neural routes, the more resourceful will be the individual.

[6] Thorndike, Woodworth, Gates, and others.

144. The Desired Responses Should Be Known. The response desired should be considered in terms of what the learner already knows, and the kind of stimuli should be provided that will tend to form the preferred routes and no others. Attempting to teach skills by trial and error, or discovery, is a direct violation of this principle. Instead of establishing the preferred routes, it establishes inefficient and indirect routes, and makes more difficult the establishment of the desired routes. Too much time is consumed in attempting to get uncertain responses, and in using inadequate and confusing stimuli. The response, or the skill to be taught, must be known, and the proper stimuli must be provided in order to get that reaction and no other. Repetition will strengthen and make certain the desired response.

Trial and error, often called intelligent self-direction, are not a satisfactory method until the skills have been developed and preferred routes have been formed. Trial and error have a place in problem solving and in planning procedures, involving the combination of routes already formed, but are not a satisfactory method when we wish to establish exact habits.

145. Convergence. The nervous system is so complex and so delicately organized that a number of impulses can unite with ease to produce a single response. One stimulus may not be strong enough to evoke a certain response. A combination of them from different parts of the nervous system may give the desired result. This is called convergence. When synaptic resistance is high, or learning is difficult, a number of different kinds of stimuli may be combined to produce

the desired response. For instance, a combination of oral instruction, written instruction, a sketch, and a demonstration may be used to teach one operation. It means, also, that it is possible to learn the same thing through more than one channel.

Convergence is common in learning. A response ordinarily is not the result of a single stimulus. A situation that produces or inhibits a response is always more or less complex; that is, rather than one stimulus, there is always a complexity of stimuli present.

146. Diffusion. The variety of connections made possible by the complex and modifiable organization of the nervous system facilitates the switching of neural routes, from simple to complex or from complex to simple forms, in reacting to various stimuli. Just as a number of impulses may unite to form a single response, as in convergence, so may a single impulse also produce a number of responses at one time. This is called diffusion. Divided attention is a good example of this type of reaction. Diffusion takes place while a learner attempts to watch a demonstration, listen to the instructor, and take notes at the same time. The learner who does not pay strict attention to his work, but has his mind partly occupied by thoughts of other activities, is another example. Effective attention is a process of convergence rather than of diffusion, although they both occur in any given situation.

147. Inhibition. While nerve impulses are thought of as producing responses, it is important to know that they also prevent responses. A learner meets the stimulus of a new and difficult problem to be solved.

He would prefer to avoid it but a stimulus, the thought of a failing grade, prevents him from acting on the first impulse. Likewise, a learner may have formed incorrect habits attempting to develop a skill without instruction. New and better habits must be formed in order to inhibit the tendency to return to the incorrect method. The stimuli for the creation of the new habit must be strong enough, and the responses must be repeated often enough, to inhibit the tendency to follow the old habit.

Inhibition may be recognized in an individual's ability to deliberate and avoid hasty decisions. Reasoning involves inhibition as well as production of responses. We often hear the remark, "I have learned by experience," which means that an individual has built up inhibitory responses to aid him in checking similar mistakes in the future. Learning is fully as much a process of inhibition of responses as a production of them.

148. Facilitation. In convergence, a number of impulses may readily unite to form a single response. It is also possible for one stimulus to reinforce another. Adding one stimulus to another makes the original one more effective. This is facilitation. Sometimes a pleasant word may be augmented by an unpleasant one in order to facilitate activity. A word of encouragement adds to one's effort in learning to perform a skill. A suggestion will facilitate the solving of a problem or the planning of a procedure. Facilitation is merely a term used to describe one of the many ways in which the nervous system functions in any learning situation.

149. Learning Not a Unit Process. The separate functions of the nervous system may be described in units, but this does not mean that they act in units. The nervous system operates as a whole rather than in separate parts. Reactions are thought of as resulting from a single stimulus, but in reality there is a continuity of complex stimuli that lead to further responses. Stimuli affecting the eye, ear, nose, and skin, together with the influence of the muscles, glands, and mental activity, form elements of a number of situations that lead to a variety of responses.

Developing a skill or gaining knowledge involves a combination of forces with inhibitions and facilitations, convergence, and diffusion always present in some degree.

150. Levels of Response. There are no sharply contrasting divisions in the nervous system, but there are many responses that seem to follow rather marked neural routes. These routes pass through three levels: (1) spinal cord, (2) midbrain, and (3) brain.

A reaction of the first level is a simple stimulus-connection-response unit. It, like other reactions, may be stated in relatively simple terms, but it is really complex, and may include any or all of the response mechanisms. The first movements at birth are first-level reactions. A sudden application of heat, or intense cold, causes immediate withdrawal of the part of the body touched. The stimulus was received by the microscopic receptors, transmitted through sensory neurones, spinal cord, and motor neurones, to the organ of response. This is also called a reflex arc. Many of the movements of the response mechanisms are re-

flexes, and the individual is not always aware of them. The flow of saliva caused by the odor of cooking, shutting the eyes to strong light, chewing food and swallowing, grasping a handle as it touches the palm of the hand are reflexes. A reflex is usually an uncontrollable movement set in action by stimuli, and it is the first and simplest reaction of the human mechanism.

The question of reflexes and the meaning of instinctive activity have aroused more or less disagreement among psychologists.[7] They are said to be so much alike that it is difficult to determine where one begins and the other leaves off.

Reactions of the second level pass through the midbrain, which is located at the base of the brain next to the spinal cord. They are more easily controlled and modified, and include more complex responses than reflexes. The movement of a foot or hand from a persistent stimulus may carry over into anger and severe kicking. Controllable movements, such as those acquired in skills and muscular habit, are said to be second-level reactions. Simple reflexes are regarded as habits started early in infancy, but the habit responses of the second level are of a higher order, and have at some time passed through a period of deliberation in at least a small degree. The skill required in distributing type is first acquired through more or less deliberation and motor adjustment. With continued practice, it functions with a mere touch of the type; it becomes "second nature."

[7]Smith and Guthrie, *General Psychology in Terms of Behavior*, D. Appleton & Co., 1924, pp. 54-56.
Watson, J. B., *Behavior*, Henry Holt & Co., (1914), p. 106.

Third-level reactions function through the cerebrum. It is regarded as the thought center, or the organ that controls deliberation. It is the main switching station of all the neural routes of the human mechanism. Stimuli of complex situations, requiring the greatest variety of reactions of which man is capable, pass through the third level. Reasoning and planning procedures for jobs are characteristic responses of this level.

While the assumption of levels of reaction enables us to describe responses that seem to indicate distinct neural routes, it must be borne in mind that human behavior is not at any time confined to a single level of response. All levels of reaction are involved more or less in all behavior. The third level controls in some degree the lower levels of response. When reasoning takes place, reactions of the first and second levels are also in operation; there is no way of knowing just how much of each. Muscular acts are in part mental acts, and the development of skill depends in some measure upon the third level. While experimental work leads us to conclude that mental adjustments are of the third level, and that it controls in part the lower levels, the definite duties of the lower levels never have been determined.

151. Consciousness. To many people the words consciousness and unconsciousness are associated with rather unpleasant meanings. It is necessary to understand these terms as referred to in learning in order that we may interpret more clearly the meaning of sensations, perception, images, and ideas. One is said to be unconscious while asleep and conscious while

awake. But there are many times in the day when one is unconscious of some things about him. A learner consciously plans a procedure for a job, and then consciously proceeds to execute each step. As each step is completed it fades from his consciousness, and he becomes conscious of another step. In learning a skill, one is very definitely conscious of each step and the manner of holding the tool; as he becomes deft in manipulation he becomes less conscious of the manner of holding it and of the succession of necessary steps in performing the operation.

It is apparent that consciousness bears with it a meaning of control of action. It is awareness of situations that call for action of the nervous system. Stimuli causing responses for purposeful activity, but not in the realm of reflex action, must be in the focus of the individual's attention; he must be aware of the situation. Mental adjustments take place, and response mechanisms are in control of thought centers located in the brain. When asleep one is not aware, and thought centers are not busy. When learning one is aware of situations, and thought centers are busy; one is conscious of situations because they attract attention: he is aware.[8] The word "consciousness," for practical purposes, may be regarded as awareness.

152. Sensations. The sense organs receive stimulations which are the first step in a stimulus-response unit. The awareness of an unpleasant odor arouses a desire to open a window, but the first step in the response is the sensation that makes the individual

[8]Dunlap, Knight, *Elements of Scientific Psychology,* C. V. Mosby & Co., St. Louis, 1922, Chapter X, pp. 202-8.

aware. Without sensation, responses would be impossible. They cause the individual to become aware of the stimuli. Sensation promptly accompanies the touch of a handle being held. Without the sensation of coldness, hardness, and pressure of an object, one would be unaware of its presence. A sensation of heat promptly attends the touch of an iron, and it makes the individual aware of the fact that it is hot. It can readily be seen that sensation always precedes experience; without it we could have no experience.

153. The Senses. All stimulations come through receptors in the special sense organs. Without these organs to interpret sensations for the nervous system, responses would be impossible. They are called special senses because there are certain sensations that are picked up through each of them. For instance, sensations of temperature, pain, and pressure come through the tiny receptors in the skin, and no other kinds of sensations come through them. Sensations of roughness, smoothness, hardness, coldness, and others, are merely compounds or blendings of these three. Likewise other sense organs have special duties to perform for the nervous system. There are about 20 sense organs[9] in the human body, but for practical purposes six of the most important ones will be discussed: sight, hearing, touch, muscular, smell, and taste. While they are discussed separately, they act in combination, several or all of them cooperating. The teacher should recognize the importance of the senses in learning, since all stimulations come through

[9]Perrin and Klein, *Psychology*, Henry Holt & Co., 1926, p. 20.

them, and they are the beginnings of all responses. Shop teachers are concerned also with the special senses, because the nature of the materials used demands a more complete use of the senses than materials in academic procedure.

154. The Sense of Sight. Visual percepts would be impossible without the effects of light waves, admitted through the pupil of the eye, on the retina. In this process, certain chemical changes take place in the retina, and nerve impulses are transmitted through the optic nerve and into the muscles. Color, form, and distance are determined in this way. The world about us would mean very little were it not for the meticulous functioning of the visual apparatus. Many cases of learning difficulty have been traced to improper functioning of this sense organ. It is very delicate and easily abused, and shop teachers should be careful that lighting conditions favor the conservation of this organ. Poor lighting conditions contribute to improper vision and learning is retarded.

155. The Sense of Hearing. Ability to hear ranks high as a factor in human behavior. One would be handicapped severely without ability to hear all that goes on about him. To hear one's friends, the sound of good music, the warning sounds of passing cars, are priceless advantages that enable people really to live and work in the world.

There is little agreement as to the exact nature of the operations involved in the intricate mechanism of the ear. But it is known that sound waves enter the outer ear, pass through the middle ear, and into the inner ear, where the sense organs of audition are

found. Sound waves are here transformed into nerve impulses.

Sound waves, or vibrations, may be classed as either *tone* or *noise*. One is pleasant; the other is unpleasant. Tones arise from regular, smooth, and constant vibrations. Noise arises from irregular, rough, and changing vibrations. The frequency of the vibrations controls the pitch. High pitch is produced by fast vibrations; low pitch is produced by slow vibrations; and there are varying degrees of pitch produced by varying degrees of speed in vibrations. *Timbre* denotes the peculiarity of the tone; that is, it identifies it as to whether it is instrumental, voice, or from some other source. The location of sound is difficult except when it is directly to the left or to the right. The sense of sight is an aid in locating sound. A blindfolded person would experience difficulty in locating sound that was not immediately to the right or left.

The auditory vibrations are complex. Single tones or noises are never received, but the individual is capable of selecting sounds from the great many that come to his ear. He becomes aware of them through choice or through intensity. The music of an instrument, or the voice of the teacher, comes through choice from other sounds. The crash of a broken band-saw, or the ring of the anvil, attracts attention because of intensity. A wide discrimination of tones and noises is an ability that man very fortunately can develop. Ability to detect sounds with respect to the proper functioning of tools and machinery is a valuable asset to the shopman. The tendency to react more favorably to pleasant sounds than to unpleasant ones is a factor

in sound discrimination. The sound of a keen tool or properly running machine is pleasant; the sound of a dull tool or improperly running machine is unpleasant. The unpleasant sounds in the shop often are warnings, though not always intense, that must be regarded with care, at least by the novice, until his sense of sound has been adjusted to shop activity.

156. The Sense of Touch. Tiny receptors in the skin pick up sensations of pressure, temperature, and pain, and transmit them into the sensory neurones and thence to the response mechanisms. The sensations that come through the skin are very complex, but they are composed of the three kinds in varying degrees and in varying combinations, like roughness, coldness, smoothness, sharpness, and the like.

Pleasant and unpleasant feelings always accompany the sensation of touch. The mechanism tends to repel the ones that are unpleasant. Scratching is a response to repel unpleasant stimuli. A feeling of roughness is repulsive and evokes a desire to avoid it. The feeling of smoothness is pleasant and evokes a desire to touch it. This may be noticed in the "feel" of the surface of a shop project. If the "feel" is not accompanied by satisfaction, a desire to avoid the object is aroused. The development of touch is important for the shopman. The little receptors in the finger-tips carry many sensations to the reacting mechanisms that enable the workman to judge better the character and correctness of his work.

157. Kinesthetic Sense. Muscular sense is kinesthetic sense, and it is often confused with the sense of touch. The fine coordination of the violinist, the pian-

ist, the artist, and the craftsman, is due to the superior development of the muscles. The development of kinesthetic sense is necessary when accuracy and motor efficiency are desired.

Sensory nerves are connected to the muscles, tendons, and joints, and sensations of weight, strain, and articulation are picked up there and transmitted to the reacting mechanisms. The fineness of development of this sense determines the ability of an individual to make adjustments in activities that require skill. Skill would be impossible for those who could not develop the kinesthetic sense. The real value of it is commonly overlooked. It is so familiar to us in our daily existence that we think of it only as movement in walking, writing, typing, lettering, and so on; and we do not think of it as fine muscular sense directed through the higher thought centers and capable of development in activities requiring the finest coordination. For many, it is a cherished gift to be able to get the hands to do what the mind directs them to do. But it is not a matter of gift; it is one of training.

158. The Sense of Smell. The sense organs of smell are two little spots or sensitive patches in the upper part of the nose. They are located above the nasal currents, and sniffing is often necessary to bring the stimulus into contact with them. All bodies of matter that give off odor are surrounded by gas which provides the stimulus that affects the nose. It is not an important sense as compared with sight and hearing, but it does contribute much to the pleasantness and unpleasantness of life. Smells are either agreeable or disagreeable, and it is only in cases of the disagree-

able that one would be glad to inhibit the sense of smell. It is a very valuable accessory sense in taste, and it also serves well in case of danger through fire, asphyxiation, and certain other conditions.

In the chemical and cooking laboratories and the shop, the sense of smell becomes so developed as to enable the individual to recognize substances in various stages of preparation; odor percepts are built up, and form a basis for recognizing other odors. One cannot recognize poor glue by the odor unless he knows the smell of poor glue; he must have a poor glue percept. And so with many other materials of the shop and the finishing-room. Smell is probably more valuable in the laboratories than in ordinary experience.

159. The Sense of Taste. The sense organs of taste are found on the back of the tongue and soft palate. All tastes are complex but they can readily be reduced to four simple ones: sweet, sour, bitter, and salt. Much of what is called taste is really odor. Gases accompany foods and medicines, and provide part of the sensation that makes pleasant or unpleasant taste. Medicine is easier to take when the nostrils are stopped up; the gas surrounding the medicine cannot penetrate the smell mechanism. Typical food tastes are difficult to recognize without the aid of the accompanying odors.

Tastes seldom appear singly; they usually appear in combination. Foods are seldom sweet or sour, bitter or salt. They are complexes of these tastes, and the possible combinations are endless.

The value of the sense of taste is limited to the tasting of foods, chemicals, and the like. As all other re-

sponses may become trained, so may taste become trained. Tea grading is an illustration of such training. One may cultivate a very keen discriminating ability in tasting.

160. Discrimination. The ability to distinguish between two things, or to single out differences among things and qualities, is called discrimination. Responses seldom occur that do not involve cooperation of the senses in discriminating things, ideas, images, and the like. The process of education is a process of developing discrimination. Learning to letter well is a complex procedure; it requires discrimination with respect to lines, and singling out and recognizing the shapes of different letters. Kinesthetic, tactile, and visual senses cooperate in such procedure.

Training enables the workman to use the various senses in the selection of materials, choosing operations and the proper tools to perform them. Whether one operation or a combination of operations would be required in doing a certain job, whether birch would be better than oak for a certain finish, whether a drawing-knife would be better than a saw for removing excess stock, are all questions of discrimination, and the ability to discriminate accurately comes from training. The difference between the crude workman and the fine workman lies mainly in the ability to discriminate the cruder from the finer things in execution. The success of one's teaching is revealed in a large measure by the keenness of discrimination developed in the pupils.

161. Sense Defects. Development of discrimination may be retarded or completely inhibited by impair-

ment of the sense organs. The most common defects are in the eyes and ears. These defects exist in varying degrees from total to only partial impairment. Even when sight is affected in slight degree, many annoying conditions arise such as nervousness, headache, fatigue, and indigestion, which lead to retardation in learning, truancy, and failure. These defects are often difficult to discover, and it is because of such problems that modern methods of health direction are encouraged. Much can be done by shop teachers as well as by academic teachers in assisting in the conservation of sight which is one of the most cherished of the senses.

Shop conditions are more conducive to visual weakness than to auditory weakness, and shop teachers should be as alert to detect them as academic teachers. Sight and hearing should always be tested in cases of retardation, slow learning, and inability to develop skills. Conditions that cause strain on the eyes should be avoided; better no shop at all than one that must be housed in poorly lighted quarters.

162. Summary. Capacity to learn is controlled by heredity. Remote as well as immediate ancestry contribute to the mental and physical possibilities of the individual. Heredity sets a limit to capacity, and environment conditions achievement within that limit. Idiots and imbeciles cannot be taught beyond their limited hereditary capacity, even though the best possible instruction be provided. Likewise, an unfortunate environment may prevent a highly intellectual individual from reaching his limit in learning. Pupils in the shop

are affected by this as well as pupils in academic classes.

All activities in life are reactions to stimuli. Every response in the schoolroom is a reaction to a stimulus, and desired responses can be controlled by providing the proper stimuli. This is the *stimulus-response* theory in learning. Learning is not due to mysterious inborn faculties, but to the adaptive possibilities of the physiological organism, of which the nervous, muscular, and glandular systems are important parts. These systems are called the learning mechanisms.

The sense organs receive sensations as the first step in a stimulus-response unit. Sensation enables one to become aware of a stimulus; without it, responses would be impossible. These stimulations come through receptors in the sense organs of sight, hearing, touch, muscle, smell, and taste. The development of these senses enables one to discriminate differences among things and qualities. Education is a process of developing discriminating ability. In the development of this ability, a combination of forces act together; inhibitions, facilitations, convergence, and diffusion are always present in some degree.

QUESTIONS—CHAPTER X

1. Why is heredity an important question in education?
2. What possibility exists for training high-grade mechanics from subnormal individuals?
3. Is it possible for normal or superior individuals to become high-grade mechanics without mechanical experience?
4. What may be the synaptic conditions of a subnormal individual who is attempting to learn skills? The bright individual?
5. What is the value of repetition in learning? How does it act upon the neurones? What is habit?
6. What relation does the development of neural routes have to the development of skills? Of habit?
7. What danger lies in attempting to teach skills by trial and error, or discovery? What is the probable influence on the neurones?
8. Why is it necessary to teach skills or fundamentals before attempting to plan procedures or to solve problems?
9. In what respect does the instruction-sheet contribute to the principle of convergence?
10. What takes place when a new habit is formed and an old one is discarded?
11. How can instruction-sheets facilitate the development of skills?
12. Through what level of response do the initial adjustments of a skill take place, and after training through what level do they probably function?
13. What is the relative importance of the various senses in specific learning situations in the shop?
14. What would you do if you had in your class a boy who writes backhanded and cannot learn skills?
15. In what respect would discrimination be of value in planning a procedure?

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CHAPTER XI

How We Learn (Concluded)

163. Perception. Learning is a physiological process. Every movement, thought, attitude, or emotion is a reaction to stimuli which come through the sense organs. The first step in a reaction is called a sensation. Sensation with a particular meaning attached becomes what is called perception. Sensations such as coldness and hardness must be associated in experience with an object before the object can be perceived. The kind of coldness and hardness which belongs to a plane-handle must be familiar before it means a plane-handle.

Perception requires past experience. Without it sensation would not bear meanings, and recognition of situations would be impossible. The sensations must have distinguishing features as a basis for discrimination, and these features must have received recognition in experience. For instance, the sensation of red must be recognized as different from the sensation of green, or other colors, before the meaning of red can be of value in perceiving something which has red as a distinguishing characteristic. We must have reacted previously in similar situations in order to perceive the meaning of new sensations.

Perception varies with individuals. Similar experiences do not carry the same meaning to all persons. This is one of the important factors affecting instruction. In shopwork it is more noticeable than in academic work, because of the tangible materials in use.

It is also more apparent in children than in adults, because children lack experiences from which meanings are acquired. The same demonstration will have different meanings for a group of sixth-grade boys and a group of high-school seniors. Perception of accuracy among sixth-grade boys carries less meaning than among high-school boys. Notwithstanding this, teaching in the lower grades should be done with as much caution, and with as much careful planning, as in the higher grades. Even though the children in the lower grades are more inaccurate and less discriminating they need to be guided carefully in forming proper perceptions. The tendency is to neglect accurate demonstrations for the younger pupils when the contrary should be the rule. Because they do not achieve as well as adults, the important duty of forming proper perceptions is sometimes neglected.

164. Apperception. Perception and apperception are essentially alike. Both require experiences that bear meanings in order for one to understand future situations which bear similar meanings; they are products of experience. The term "apperceptive basis" means that the learner has gained certain experiences which enable him better to understand a new situation. In order to draw a spur-gear, there are certain fundamentals which must be known, such as the involute curve, pitch diameter, diametral pitch, circle of centers, the clearance circle, and so on. These form an apperceptive basis for drawing the gear; the draftsman must understand them and know how they are applied; he must have had experience with them before he can proceed. A learner who is lacking in fundamentals

lacks an apperceptive basis for understanding more advanced problems.

It is important that the instruction in shopwork be brought to the apperceptive level of the learner. This only means that his past experience and training must be taken into account. The subject-matter must be chosen so that the pupil will pass from the simple and familiar experiences to the more difficult and unfamiliar. The elementary and most frequently used operations must be taught first, if they have not been learned previously, in order to prepare an apperceptive basis for the advanced and more complex ones.

One needs only to refer to the psychological basis of learning to understand the confusion caused by the selection of jobs as the instructional units; they usually are too complex to permit proper perceptions of single skills. We cannot be sure that one job will form a satisfactory apperceptive basis for doing another, as they may not be composed of similar elements. Instructional units based on operations, and applied in suitable jobs, assure greater probability of building proper perceptions, and thus preparing an apperceptive basis for the solution of new jobs.

165. Images. Images are sensory impressions of something not present. We perceive a thing that is present through the sense organs, and retain an image of it after it is gone. Impressive stimuli resulting in clear percepts contribute to the ease of forming images. The ability to form images through a wide variety of stimuli is an indication of resourcefulness.

There are differences in ability to form images, just as there are differences in ability to form perceptions.

Sensations and perceptions prepare the way for images and contribute to the differences in ability to form them. These differences have led many to believe that there are imagery types of learners; that some can form images better through one kind of stimulation than through another. For example, it is thought that some learners form images better through printed words, others through pictures, others through spoken words, or through other avenues of presentation. Based upon this point of view, it is also thought that one of the teacher's problems is to discover the pupil's particular kind of imagery, and to take advantage of it in the method of teaching.

While it is true that there are imagery types of individuals, it is not because of heredity, but rather because of exercise of a particular type of imagery to the neglect of some other type that might have been developed.[1] For instance, continued reading will enable one to gain special ability for forming images through reading, and such an individual will learn best by reading. Continued observation and listening will enable one to gain special ability to form images through observation and listening, and such an individual will learn best by observing and listening.

Experiences beginning early in childhood are important in developing imagery types. Many habits, often believed to be inherited, really have been developed in early childhood. Although imagery types are often developed in this way, they may be formed at any time when conditions are favorable for forming

[1] A. I. Gates, *Psychology for Students of Education,* The Macmillan Co., 1924, p. 281.

them. An adult, as well as a child, may develop ability to learn through a particular kind of imagery. The process of learning is a process of adding to, and changing, the stock of images already present. Forming imagery types comes as a result of exercise of particular kinds of images. Neural routes are formed over the synapses which make connections easy for the trained types.

It is encouraging for the teacher to know that imagery types come as a result of training. It means that good teaching can overcome a situation which has been believed to be impossible of improvement. It means that instruction can be presented through many channels, and new types can be formed through exercise. Imagery types are not inherited; they come as a result of training. There are as many kinds of images or ideas as there are sensations and meanings, and all people possess, in some degree, the ability to acquire all types of them.

166. Ideas. Ideas are said by some psychologists to be composed of groups of percepts and images. Perceptions arise from something present, and images are retained in its absence. Perceptions are as fixed as the thing observed. Images can be changed at the will of the individual because they are sensory impressions; and since ideas are composed of groups of percepts and images they also can be changed. They can be grouped and regrouped to meet the fancy or desires of the one who possesses them.

One of the differences between man and the lower animals is the ability of man to form ideas. One difference between the pupil who learns readily and the

one who learns slowly is that the former is resourceful in the ability to combine and recombine his stock of ideas in order to meet new situations. Ideas carry an individual beyond experience; and there is no limit to the number of new ideas that may be formed through the combination of old ideas and the result of new experiences. Were it not for experience, it would be quite impossible to form ideas, and were it not for ability to form ideas, little would be gained from experience.

167. Feelings. We are aware of situations because of feelings; pleasantness or unpleasantness invariably accompanies every situation. Man lives in a continuous state of feelings. It is impossible to conceive of any experience that does not carry with it either a feeling of pleasantness or unpleasantness. It is the human reaction to all experience; life would be indifferent without it; it seems to fix values to everything. The artistic is pleasant and the crude is unpleasant; sweet is pleasant and bitter is unpleasant; success is pleasant and failure is unpleasant. A feeling of pleasantness is associated with a job well done, or a skill mastered. A feeling of unpleasantness accompanies failure. And thus in all events of life we have feelings of pleasantness or unpleasantness. They serve as controls of action. We are continually attempting to do those things that are pleasant: gain success, obtain food, seek entertainment, and rest; and to avoid situations that deprive us of any of these things.

The physical basis for feeling is unknown. There is nothing in the nervous system that indicates where any

particular part of it functions. It seems to affect the whole organism. Unpleasant feelings indicate that the organism is out of adjustment, and pleasant feelings indicate that the organism is in adjustment with an existing situation. The organism is at its highest state of efficiency when it is in adjustment with the world about it. Unpleasantness is depressing and saps vitality, and, if continued, harm often results. A further study of the influence of unpleasant feelings in learning is discussed in Chapter XII.

168. The Law of Readiness. Feeling accompanies all responses and fixes values to them. It places the organism in a condition that favors or hinders the flow of impulses over the synaptic connections so that conditions become favorable or unfavorable to learning. When the synaptic conditions are favorable to learning, one is said to be in a state of readiness, and when they are unfavorable to learning, one is said to be in a state of unreadiness. For instance, when a learner is busily engaged in developing a skill, he is in a state of readiness with respect to learning that skill, but he would be in a state of unreadiness if he is asked to stop his work and write an analysis for a new job. It would be necessary to wait until he is through with the first skill, or to induce him, through some appropriate means, to want to analyze the new job. We must get him into a state of readiness before he can perform the new task effectively.

These states of readiness or unreadiness are either pleasant or unpleasant. The satisfaction or pleasantness of the experience accompanying the learning of the skill produces an inner urge to continue and make

it attractive. To be interrupted during the experience of pleasure by something that holds uncertain promise would be annoying.

"To do those things which we want to do, or for which we have impulses, is satisfying. Not to do those things for which we have impulses is annoying. To be forced to do those things for which we have no impulses is also annoying.[2]

To eat when one is hungry is satisfying; not to eat when one is hungry is annoying; to be forced to eat when one is not hungry is also annoying. And so in learning. To learn when one wants to learn is satisfying; to be denied the opportunity to learn when one is ready to learn is annoying; to be forced to learn when one is not ready to learn is also annoying.

One of the teacher's most difficult problems is to get the learner into a state of readiness to learn. Little good can come from demonstrations or written instruction if the learner does not want to learn. The first step in teaching is to develop an active desire to learn. For instance, a feeling of need attached to a skill or a problem is often a good motive; it promotes readiness and gives personal satisfaction. Learning is determined entirely by reaction tendencies which are controlled by feelings.

169. Mind-Set As It Affects Readiness to Learn. There are several factors which influence the organism with respect to readiness to learn. Mind-set, influenced by emotions, health, and heredity, is probably the most common. Mind-set should be regarded as primary to all others. It always precedes readiness,

[2]Thorndike, Kilpatrick, Gates, and others.

and it may be affected by many internal and external conditions.

Mind-set is determination to gain an end or to retain an existing state of affairs. It may be unpleasant for the time being, but the ultimate result will be satisfaction if success is attained. The boy who is assembling his radio has a mind-set for it, but he probably has no mind-set for grammar at that time. It would be difficult to get him into a state of readiness for a lesson in grammar; at least until the radio is assembled. The boy who is busily engaged in developing a skill has a mind-set for it. Mind-set in this activity would be a hindrance in attempting another. He must feel that it would fulfill a greater need, and be more promising of satisfaction than the original one, in order to get him into a state of readiness to learn it. Mind-set or determination to do a thing, accompanied by prospects for success, invariably aid the learner in gaining the desired end.

Emotions such as fear, worry, and anger, tend to inhibit mind-set and readiness to learn. In such cases the processes are interrupted and synaptic resistance to learning is set up. Internal factors, such as organic difficulties, or external factors, such as the attitude of the instructor, may arouse the emotions, and thus interrupt the neural processes and delay readiness to learn in members of the class.

Ill health acts in much the same way as the emotions in confusing the neural routes. There are many unseen conditions relative to ill health which reduce, in some way, an individual's desire to learn. Even the individual himself is often unaware of its influence,

and mind-set may carry him over to success. A nervous system impaired by ill health cannot serve effectively in learning.

Inherited characteristics control the capacity to learn. An individual who is deficient in any of the components which enable him to learn will experience difficulty in learning; mind-set and readiness will be absent in proportion to the degree of mental deficiency. Mental deficiency means that the adaptive possibilities of the nervous system and glands are inhibited by nature; and mind-set and readiness depend upon the condition of the neurones and the possibility of building neural routes through them. Ability to develop states of readiness also varies in individuals according to their inherited adaptive possibilities.

Readiness should bring satisfaction, and satisfaction also comes with success. Success leads to further success and keeps the mind in fettle for more learning. The successful development of a skill leaves a state of readiness for attempting another, and another, and the more skills one develops the greater the tendency to remain in a state of readiness for developing further skills.

All annoying conditions tend to reduce readiness to learn. Failure develops unreadiness, and sets up an attitude of avoidance toward the situation which accompanied it. In order to encourage learning, situations must be set up so that some chance of success shall accompany them. The instruction units must be brought to the apperceptive level of the learners, and they must be presented so that clear percepts can be made or failure will result.

170. The Law of Effect. Consideration of the Law of Readiness leads directly to a consideration of the Law of Effect. It is rather difficult to determine where one leaves off and the other begins. *Readiness* is a condition of the neurones which encourages effort in learning, while *effect* is the result of such effort in terms of feelings which control further effort. Gates[3] states the Law of Effect as follows:

"The individual tends to repeat and learn quickly those reactions which are accompanied or followed by a satisfying state of affairs. The individual tends not to repeat or learn quickly those reactions which are accompanied by an annoying state of affairs."

The tendency of a learner to want to continue in the development of a skill is due to satisfaction because of apparent success. He has a feeling of accomplishment, and it is pleasant. A contrary attitude may be experienced by the same learner who is not rewarded by early indications of success; he is ready to quit and do something that holds promise of better feelings. All life seems to be guided by the Law of Effect. We are attracted by and tend to repeat satisfactory experiences, and we avoid annoying ones. We hesitate before attacking new experiences which seem to offer the slightest semblance of annoyance, but mind-set may carry us over and success may be achieved with its accompanying feeling of satisfaction. The same experience encountered again may be attacked with greater zest because of the assurance of success gained from the first experience. If the initial experience re-

[3]Gates, A. I., *Psychology for Students of Education,* The Macmillan Co. (1924), p. 23.

sulted in failure, which is annoying, that problem would be attacked again with greater reluctance or avoided entirely.

The Law of Effect functions in the shop as well as in our daily experience. The desired responses must be known to the teacher and to the learner, and the proper stimuli must be provided so that success in some form may be achieved. The subject must be organized so that it may be presented in definite units capable of mastery by the individual. In the beginning it is highly important that these units be small in order that the pupil may feel frequently the stimulus of success. Success in the mastery of a skill, or in the solution of a problem, is satisfying and attracts the individual to the same kind of recurring experience. He will repeat the experience, and repetition means learning and habit building.

All learning is subject to the Law of Effect. The more certain the success, the greater the desire to learn; the more probable the failure, the less the desire to attempt the problem. Shop experiences accompanied by success and satisfaction tend to become fixed in the mind of the learner, and shop experiences associated with failure or a tendency to failure and annoyance tend to fade from the mind of the learner.

Anything that hinders the opportunity for success should be avoided in shop teaching, but there are often situations that arise in which annoyance must be used to inhibit an attitude or to break a habit. Annoyance should be attached to the undesirable response so the learner will avoid it in the future, and satisfaction should be attached to the desirable response so the

learner will repeat it. An individual who has successfully developed a skill should know it, and he should receive recognition and approval. The learner who is indifferent and fails should know it, and his attitude should meet with disapproval. In some cases of failure, recognition of a minor success along with the annoyer often leads to increased effort toward further success.

Advantage should be taken of the features in a situation which indicate partial success, and by properly attaching annoyers to the portion indicating failure, and satisfiers to the portion indicating success, improvement may be made in the learner's efforts. He will discriminate between the satisfaction and the annoyance, and choose the more satisfying as a guide to future conduct. Even low grades are annoyers; they represent degrees of failure, and the learner can avoid them by doing better work. Good grades are satisfiers, and lead to more good grades.

Danger lies in the misplacement or misuse of annoyers. The teacher should use great care at all times. Attaching annoyers to undesirable responses is punishment. Coercion, which is a form of punishment, should be used only after all other methods fail. Success and failure often combine in the execution of a skill. While the execution may be generally good, there may be imperfections, and the teacher needs to weigh the value of one against the other. Discretion must be used in attaching any kind of annoyers, because they may cancel entirely the effects of more valuable satisfiers already present. The use of satisfiers to gain results is more indicative of good teaching than a liberal use of annoyers.

171. The Law of Exercise. An individual tends to repeat satisfying situations. In learning, it means repetition, and repetition builds habits. Repetition is the *use* factor in the Law of Exercise. When an act has been repeated often enough, preferred routes are formed in the neurones, and synaptic connections for that act are readily made. The more frequent the act is repeated, the greater the ease of performance because of the favorable changes in the condition of the neurones.

The development of skill in the shop requires repetition of the act. One squaring problem in woodwork, or one experience in locking up a form in the print-shop, or one plate of sectional views in mechanical drawing, is not sufficient to build a well established habit. The original response must be strong, and the repetition must be frequent, in order to build the desired habit in any one of them. There must be enough repetition thoroughly to establish neural routes in the nervous system for the desired skills.

The frequency of repetitions required to build habit depends upon the intensity of the stimulus that evoked the original response, and the ability of the learner. A poorly conducted demonstration or poorly written instruction-sheet is a weak stimulus, and will result in uncertain responses requiring adjustments and more repetition in order to develop a habit. An individual of mediocre ability requires a more intense stimulus and a greater number of repetitions than one who has a high degree of ability.

Repetition must come at close intervals; there must be recency. Experiences in any given skill should not

be separated by long intervals of time if habit is to be formed. The longer the time of disuse between repetitions, the less will be the probability of developing the habit. This is the *disuse* factor in the Law of Exercise. All learning tends to weaken with disuse. It is not at all unusual for an individual to find that he does not letter as well after the lapse of a year. The neural routes have been weakened, and use is required to strengthen them. Since disuse weakens, it is apparent that the application of instruction should come immediately following the demonstration. Teaching today what may not be used until tomorrow is of little value; there must be recency.

The Law of Effect and the Law of Exercise work together. The satisfaction and the annoyance of a situation control repetition. The satisfying experiences are repeated, and the annoying ones are avoided. The more intense, the more recent, and the more frequent the satisfactory experiences, the more promptly the habit will be formed. The more intense, the more recent, and the more frequent the annoying experience, the less promptly will the habit be formed.

172. Summary. The first step in a learning situation is sensation, and it must bear meaning before it can be of value to the learner. Past experience provides the meaning. With meaning attached it becomes a percept and proper percepts are necessary for learning. When these percepts have been formed in any activity an apperceptive basis has been formed which enables the individual to interpret new and similar situations.

Perception varies with individuals. It is influenced by heredity and experience. Mature individuals per-

ceive better than children because they have acquired more experience. These differences must be taken into account in the preparation and presentation of subject matter. Complexity must be avoided if clear percepts are desired.

Images follow percepts. Imagery types of learners are not the products of heredity but rather the products of experience. This is important for the teacher. Imagery types, if caused by heredity, would seriously handicap teaching. It would mean that all individuals possess certain kinds of imagery that would be difficult to change. Learning means making changes in individuals, and good teaching produces these changes if the individual is adaptable. Ideas may be combined and recombined to meet new situations. The ability to do this is characteristic of individuals who are resourceful.

Feeling accompanies every sensation. Without feeling experience would be indifferent. Feeling enables the individual to react favorably or unfavorably to situations; it serves as a control of action. We are attracted by the pleasant and avoid the unpleasant. This is the guiding factor in the Laws of Learning. Feeling either favors or hinders the flow of impulses over the synaptic connections. When the synaptic connections are favorable to an existing stimulus, one is said to be in a state of readiness; it produces satisfaction. The actual functioning of the Law of Readiness leads directly to the Law of Effect. We are attracted by and tend to repeat satisfactory experiences, and we avoid annoying ones. Success is satisfying, and we tend to repeat it. While mental set may carry one over diffi-

culties, success in some form must be evident. Failure is annoying, and every individual tends to avoid it and seek something that gives promise of success and satisfaction.

The Law of Exercise functions immediately with the repetition of experience. A habit cannot be formed without repetition. The more intense, the more recent, and the more frequent the satisfactory experience, the more certain will the habit be formed.

QUESTIONS—Chapter XI

1. Are definitions sufficient to enable the individual to form percepts, or should he have first-hand contact? Are good sketches of value as aids in the formation of percepts?
2. What is perception?
3. Why should the apperceptive level of the learner be considered when presenting a lesson?
4. Why would the selection of a job as an instructional unit be a hindrance in forming proper percepts and in forming an apperceptive basis for doing other jobs?
5. How do children differ from adults in forming proper percepts, and why?
6. Compare sensations, percepts, and images.
7. Why is it valuable to know that imagery types come through experience?
8. What is an idea? Why is the ability to form ideas valuable in learning?
9. What is meant by the statement that repetition must be accompanied by satisfactory results?
10. State the three major Laws of Learning, and give a good illustration of the use of each.
11. Choose an operation to be taught, and tell how it may be developed into a habit.
12. How will a well written instruction-sheet add to the frequency, recency, intensity, and resulting satisfaction in the functioning of the Law of Exercise?

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CHAPTER XII

Emotions, Feelings, and Attitudes

173. Emotions. The study of learning behavior would be incomplete without consideration of the inborn drives or impulses which influence the action of the learning mechanisms. They are the reactions of the inner muscles and glands which are not subject to training but which proper stimuli will bring into action. Fear, surprise, anger, affection, elation, enthusiasm, worry, melancholy, and disgust, usually accompanied by increased heart action, perspiration, gastric and glandular disturbances, are all activities that, in a more or less obscure way, aid or retard achievement, detract from or contribute to health, and add to happiness or disappointment. It is of special importance that the influence of these activities should be understood by shop teachers because the learning process is the same in one field as in another and the learners are subject, in varying degrees, to the same drives or impulses.

In our everyday experiences there are many activities of which we are seemingly unaware which are aroused through definite stimuli. Noises in the shop, street lights, passing cars, and striking clocks arouse certain responses of the bodily mechanism without attracting our attention to any considerable degree. However, an extreme or unusual noise, such as an explosion or an outcry, attracts attention, and may cause increased heart action, fear, or perspiration. We become aware of such reactions, but have little or no control

of them. Appropriate stimuli also arouse affection, elation, enthusiasm, worry, melancholy, and numerous other responses. These are complexes of sensations which arouse the whole body to reaction without apparent inhibition. They are the emotions.

174. Internal Disturbances Caused by Emotions. As a result of experimental work, psychologists have learned that the emotions, while exhibiting outward responses, also stimulate or retard action of the digestive, nerve, and glandular mechanisms. A common experiment in the study of emotions has been to observe, through the fluoroscope, the digestive action of a cat following the arousal of anger or fear. It has been found that in extreme fear or anger the digestive action ceases entirely and is slow to regain its function. Further experimental work has proved that internal disturbances also take place in man during emotional upsets. It is not uncommon for individuals to have headaches, lose appetite, have a sinking feeling, or become sick or "dead scared," as a result of worry, fear, excitement, anger, surprise, or other unpleasant emotions. Extreme happiness, enthusiasm, and affection are also known to arouse similar reactions.

In the case of fear, anger, or other strong emotions, the glandular activities of digestion and the flow of saliva cease, the heart beats rapidly, a high blood pressure is produced, breathing is deeper, and the adrenal glands secrete adrenalin into the blood stream which, through its effect on various parts of the body, results in increased strength and endurance. It affects the liver and causes it to force large quantities of sugar into the blood. One whose anger is aroused can fight

harder, and one who is frightened can run faster, than one who is not thus aroused. Energy is expended in excess and when the supply is gone, the individual is left in a subnormal condition; he is fatigued.

175. Learning Is Retarded. The arousal of strong emotions and the accompanying physical changes are of doubtful value in the learning process. While strength may be increased temporarily, the ability to do clear thinking is retarded. The learner who is nervous or angry makes mistakes in skills and in reasoning. It is probable that diffusion of impulses takes place in the nervous system, and existing neural routes are more or less obstructed immediately following reception of the stimuli. It seems to affect all neural routes because an individual reacts all over the body to emotional stimuli, and clear thinking is inhibited. Emotional stimuli act as "interference" to any regular responses.

Since the emotions tend to inhibit clear thinking, it may be of value to know that clear thinking may also tend to inhibit the emotions. Becoming master of a situation is the result of clear thinking brought about by sustained effort. One needs only to gain an initial success during an emotional upset to lead to better feelings; and better feelings are encouraging and tend to inhibit the emotions.

The arousal of the opponent's emotions is a common practice of contestants because of the detrimental effect on the reasoning ability and skill of the opponent. The learner who is nervous, overanxious, or chagrined, cannot reason well or readily develop skill.

176. Worry. All the emotions produce internal

changes in some way, and when often indulged become easily aroused. Frequent anger, fear, worry, melancholy, and excitement eventually result in destruction of health. Temporary paralysis of the digestive organs and excessive action of the heart, arteries, liver, and kidneys cannot continue without serious deterioration of the mechanisms involved. Worry is one of the greatest offenders in the breakdown of the human mechanism. It is a secret fear that something will happen or will not happen. While in its earlier stages it may not produce noticeable effects, it eventually results in disturbances similar to those arising from extreme fear. Worry becomes a habit; a habit which is easily formed in children as well as in adults. The nervous system forms easily a condition of readiness to react to things which produce worry in preference to other stimuli, and eventually worry comes without reason for it.

Indecision is another form of worry. It is really worry over the proper course of action, and soon the nervous system becomes adjusted to it and indecision becomes a habit. When in training, children as well as adults should be given opportunities and encouraged to make decisions and to stay with them. Uncertainty about action may often be avoided by careful planning and study. Satisfaction comes from taking the course that indicates the highest merits. Unwise decisions are annoying. Wise decisions are satisfying and result in greater ease in forming new ones.

Much can be done by teachers who recognize worry as a great existing evil which hinders good teaching. Because it is one of the milder emotions, the individual

is unaware of its insidious progress until it has produced serious results.

177. Emotional Responses Vary With Individuals. Individuals respond to emotional stimuli in varying degrees. Some may be affected by the slightest provocation, and others may be unaffected by the most intense stimuli. The response is a physical reaction that appears in proportion to the stability of the inner mechanism. The inherited nervous system undoubtedly is a factor in conditioning responses to emotional as well as to other stimuli. A weak nervous system is fertile ground for developing tendencies toward emotionality. Those who are easily aroused, and who often are in a state of aroused emotions, are said to be overemotional. Those whose emotions are little aroused are said to be underemotional. We find these types in varying degrees among our learners. It is the overemotional rather than the underemotional individual who may have the most difficulty in learning.

178. Feelings Make Us Aware of Emotional Condition. Emotions are accompanied by feelings of pleasantness or unpleasantness, and these feelings make us aware of the emotional condition. We desire experiences which are pleasant, and we avoid experiences which are annoying. Fear, anger, worry, grief, ridicule, humiliation, and punishment are always accompanied by unpleasant feelings. Enthusiasm, happiness, zeal, are always accompanied by pleasant feelings. They have a beneficial effect on the work we attempt; they lead to success. Unpleasant feelings have a retarding effect; they lead to failure. Success is accompanied by pleasant feelings and it leads to further

success. Failure is accompanied by unpleasant feelings and it leads to further failure.

Pleasantness usually accompanies natural and easy movements in skills, but unpleasantness interrupts them. When the new skill or idea must compete with, or is accompanied by, unpleasantness in the mind's focus, learning is difficult. In rare cases a feeling of unpleasantness may serve to arouse the learner to greater effort in order to gain success and pleasantness. However, it should be the last resort in teaching, and when used it should be made clear that the escape from it is through success. All individuals do not react to it favorably.

179. Attitudes Repress Emotions. It has been stated that emotions are not learned and cannot be controlled. However, attitudes can be developed in individuals which serve as effective brakes in repressing, or curbing, undesirable thoughts that stimulate the action of the emotions. Attitudes are learned and can be controlled. They come as a result of clear thinking which enables the individual to react successfully in overcoming emotional stimuli.

Self-consciousness and self-love are two attitudes which hamper the work of the classroom. The individual who is self-conscious has divided attention and lacks ability to concentrate, and as a result he is likely to make mistakes. Attention must be focused on the real problem, and worrying about inconsequential details interferes with the process of learning. Lack of confidence is closely related to self-consciousness; they usually act together. Experience in doing skilful work develops confidence and tends to reduce self-conscious-

ness. Insufficient experience of lack of ability reduces confidence and tends to increase self-consciousness. The inexperienced teacher may make mistakes in execution during his first demonstration, but after a few repetitions confidence is gained and execution is improved. The learner likewise may not do as well during his first attempts in performing a skill, but confidence comes as a result of repetition and success. Self-consciousness is also a form of worry; it comes from thoughts of unpleasant things which might occur, and which usually do occur because of divided attention. The self-conscious individual is encountered frequently and deserves sympathy but it must be free from indulgence.

Self-love is an attitude which tends to turn the mind inward and away from the problem. Feeling sorry for oneself, or thinking of one's less fortunate experiences, leads to failure. Anger, fear, nervous irritability, egotism, and worry accompany self-love. All of these interfere with the thought processes, and result in physical disturbances. Thinking of other persons and of other things develops self-control that acts as emotional control. It establishes a habit of looking outward rather than inward. It adds to the desire to learn with its accompanying feeling of satisfaction.

180. Attitude of Teacher. The beginning learner is subject to frequent emotional disturbances. Satisfactory experiences and feelings at the start are desirable in order to allay the effect of such unpleasant emotions as fear of failure, doubt, indecision, and self-consciousness. One characteristic of a well developed skill is the ease and form with which it functions, and

it comes as a result of pleasant rather than unpleasant feelings. Learners who have tendencies to emotional instability require individual and sympathetic attention. Calmness and poise on the part of the teacher are essential. No other single factor is so helpful in eliminating emotional instability. Coercion leads to harmful results.

Young people are subject to emotional upsets to a degree that adults often do not realize. Fear, worry, and grief are common. Ridicule, humiliation, and punishment are foremost in the emotional disturbances of children as well as adults. Children are not always as happy and carefree as we assume. Continued emotional disturbances in children are often responsible for physical and mental disturbances that arise in adults. Keeping this knowledge before us as teachers, we should control our attitudes in the presence of learners; ridicule, humiliation, and punishment do not often bring satisfactory results. An attitude of interest in, and sympathy for, the learner and his problem serve to allay the emotions and encourage learning.

The sympathy must be genuine and come from real interest in the pupils. Introspection often serves as an excellent guide in the teacher's conduct with respect to this point. The delinquent should be held accountable for his actions; being easy with him is not being sympathetic. Such an attitude on the part of the teacher is not respected by the pupil. Firmness and calmness, tempered with kindness, are respected.

Emotional disturbances often arise out of overanxiety to succeed. Beginning learners of any age are subject to it in greater degree than more advanced

ones. A learner in lettering is inclined to be nervous, and makes mistakes. Ease of coordination is absent, and the ability to develop skill is affected by his emotional state. Extreme nervousness, overanxiety for success, fear of doing wrong, or fear of ridicule may disturb concentration and retard development of coordination. Should the learner be overemotional he may never learn to letter well. Each individual deserves the sympathetic attention of the teacher.

Sometimes a teacher who is under an emotional strain, or a teacher who fails to recognize the emotional strain under which a pupil is working, may seriously interfere with the progress of the work by ill considered action. To illustrate: a boy in the grades was attempting to plane a chamfer on a bread-board. It was his first attempt following the demonstration, and he was not entirely successful. The teacher apparently was under an emotional strain and although he attempted to control his attitude, his expostulation led to further difficulties. The boy was soon in tears. He had tried hard in his first attempt, and needed sympathy and encouragement. It required ten minutes of the teacher's time to correct the damage he had done and to effect a change in the boy's emotions.

Difficulties in learning can best be located by the teacher under normal learning conditions. Feelings of satisfaction result from achievement, and achievement comes best when the strong emotions are undisturbed.

181. Failure of Method May Be Detrimental to Learning. Emotional disturbances may come to a teacher as a result of failure of his methods of instruc-

tion. He may become dissatisfied because of his failure and without recognizing the cause, blame the pupils for dulness, and thus develop an unsatisfactory emotional reaction among the pupils.

On one occasion several pupils informed the supervisor that they could not tolerate a certain teacher. He kept them "riled up," and the longer they remained in his class the less they learned. The teacher appeared to be annoyed by questions and requests for information, and was short and snappy in his replies. The supervisor investigated quietly by visiting the room for extended periods, and in talking with the teacher he inquired about his progress. The teacher replied that the ignorance of the pupils and their lack of preparation and inability to understand was getting on his nerves, and that he could not get results although he was using the best of modern methods—intelligent self-direction. This provided a clue for the supervisor. On further questioning, it was learned that the teacher had not made a distinction between the methods required in teaching skills and those required in solving problems. He was using "intelligent self-direction" in attempting to teach skills.

Skills are exact habits, and are not learned by chance or discovery. They must be taught as specific habits of performance. The learner may use "intelligent self-direction" in planning his procedure, or in solving his problem, but he should not be expected to discover the skills. In the case just cited, several conferences led to a new approach in teaching; the emotional tension subsided; and the pupils and teacher became satisfied.

182. Summary. It is of special importance that the influence of the emotions in learning be understood by all teachers because all learners tend to be more or less emotional. The arousal of emotions leads to internal disturbances, and, if continued, health is endangered. While fear, anger, excitement, and surprise are common, the most destructive of all emotions is worry because of its insidious progress. Ill health may appear before the individual has opportunity to realize that it has been produced by worry.

Clear thinking is retarded by emotional upsets, and when this occurs even the best teaching is not effective. Emotionality varies with individuals, and feelings determine the degree of emotionality; they make one aware of the emotional condition. Pleasant feelings accompany natural and habitual movements in skills; unpleasantness interrupts them. Proper attitudes can be developed which facilitate clear thinking and control of emotions. This applies to the teacher as well as to the learner. An attitude of interest in, and sympathy for, the learner and his problem serve to control the emotions and encourage learning. Ridicule, humiliation, and punishment are detrimental. Normal learning conditions are desirable at all times.

The method of selection of instructional units is also a factor in maintaining normal learning conditions. When the instructional units are improperly selected, confusion arises because of the learner's inability to react to the indefinite or inadequate stimuli.

183. Observation Problem.

Assignment: Go quietly into the classroom assigned

to you. Take necessary notes, and make a written report for conference covering the following points:

1. Did you observe any emotional disturbance among the pupils? If so, what were the character and cause of the disturbance?
2. How did the teacher handle the case? Did his methods appear to be effective?
3. Did the teacher show any evidence of emotional disturbance? If so, in what respect, and what effect did it have on the situation?
4. Observe a situation in which a learner has made a mistake, and determine whether it was due to incorrect stimuli or nervousness.
5. What is the general attitude of the teacher toward the learners?
6. What is the attitude of the teacher when he finds mistakes in the learner's work? How can his attitude be improved?
7. Did you see coercion used at any time during your observation? What was the effect?
8. Observe a situation in which the learner achieves success. What were his reactions and the effect of success on his attitude toward his work?

QUESTIONS—Chapter XII

1. What are the emotions?
2. What is the danger of continued emotional states?
3. How does extreme nervousness affect the development of skill?
4. How would you deal with an overemotional pupil?
5. What is meant by attitude?
6. Give a good illustration of self-consciousness impeding proper responses in a given learning situation.
7. How can a knowledge of the emotions be of value in maintaining discipline? Are young children as carefree as they seem?
8. How can the proper selection of instructional units serve in maintaining normal learning conditions in the shop?

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CHAPTER XIII

Individual Differences

184. Heredity and Environment the Causes of Individual Differences. While individuals in a given class and of a given age appear to have a number of characteristics in common, there are differences among them with respect to the majority of human characteristics. Heredity and environment are the principal causes of these differences.[1] We inherit outward physical characteristics, and also characteristics of the nervous system, glands, and other inner organs which have an influence on learning behavior.[2] What an individual may possess in the way of abilities, and possibilities of growth is determined by his inherited nervous system, but the environment determines the ultimate development of these characteristics.[3] Differences due to inheritance, sex, and maturity, together with variation in kinds of environment, produce in total the great problem of individual differences.[4]

185. Nature of Individual Differences. Individuals are made up of an endless number of abilities and traits which all people possess in some degree.[5] The differences among people are primarily a matter of

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[1] A. I. Gates, *Psychology for Students of Education,* The Macmillan Company, 1924, p. 409.

[2] Ibid., pp. 68-71.

[3] H. E. Walter, *Genetics,* The Macmillan Co., 1913, pp. 2-4.

[4] E. L. Thorndike, *Psychology,* Vol. III, Teachers College, Columbia University, New York, 1913, p. 144.

[5] Ibid., pp. 366-387.

the degree in which they possess these characteristics,[6] and in the way in which they are organized. The nature of the differences in any of these traits is such that for a large group of people the traits follow a normal distribution curve.[7] This is called the probability curve. See Fig. 9.

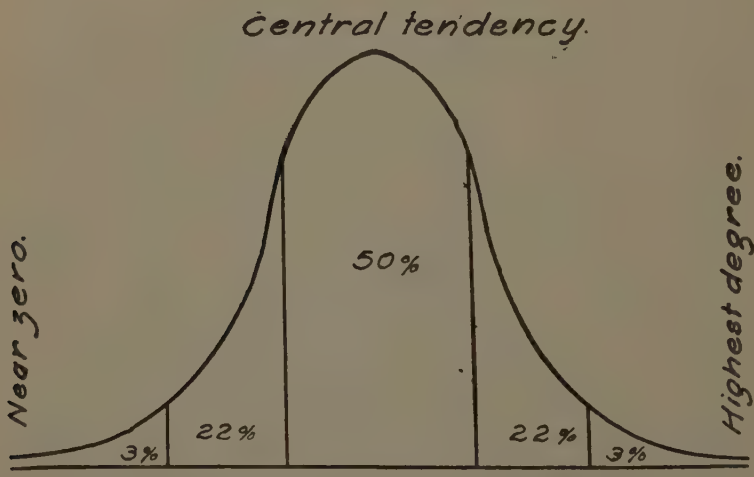

FIG. 9. Diagram to illustrate the probability curve.

Mental and social traits as well as natural phenomena, due to laws of chance, tend to be distributed about a central tendency in proportions from near zero to the highest degree. Measurements of the weights of a thousand men would tend to fit this curve. For practical purposes the base-line may be divided into five parts, and 3 per cent of these men could be classed as very short; 22 per cent, short; 50 per cent, average (these are often referred to as the middle 50 per cent); 22 per cent, tall; 3 per cent, very tall. In the same way other traits may be measured, and the results in graph form for large unselected groups tend to fit this curve. Grades and scholastic measurements likewise tend to fit it.

[6]B. R. Buckingham, "Intelligence and Its Measurement," Journal of Educational Psychology, XII, May, 1921, 271-274.

[7]E. L. Thorndike, op. cit., Chapter XIV.

186. Classification of Characteristics Suggestive Only. Individuals have been divided into three general classes with respect to mental characteristics: (1) those having the capacity to deal effectively with abstractions; (2) those having the capacity to deal best with the concrete; and (3) those having a strong tendency to action and leadership. These classes are not mutually exclusive but overlap, and in many persons all three general characteristics may be present. These characteristics are believed to be the result of environment and training, which have developed highly noticeable habits of the particular type; and good teaching can effect changes in these attitudes and habits within the level of the mental capacity of the individual.[8] It is encouraging and helpful to know that habit is often the cause of many misunderstandings about learning. It should brighten many a hopeless teaching situation, because it suggests that teaching is habit building; and good teaching will produce desirable changes in the habits of individuals.

187. Cannot Be Divided Sharply Into Groups. It is important to know that individuals cannot be divided sharply into groups on the basis of these characteristics,[9] as suggested in Fig. 10. The heights of men in a large group cannot be truthfully classed as short, medium, and tall; instead they range in continuous series from the shortest to the tallest. Likewise, the possession of mental traits by a large number of people vary from the smallest degree, or idiocy, in continuous

[8] S. S. Colvin and W. C. Bagley, *Human Behavior,* The Macmillan Company, (1913), Chapter 2.

[9] F. A. C. Perrin, and D. B. Klein, *Psychology,* Henry Holt & Co., 1926, pp. 368, 369.

gradation to the largest degree, or genius,[10] as represented in Fig. 11.

This fact suggests that the exact amounts of differences between individuals may be difficult to determine. Physical differences can be observed and measured directly; but degrees of mental differences cannot be so readily observed, and can be measured only indirectly through tests and achievement.

Even the observation of faces will not give us information with respect to the individual's capacity to learn. Many of the world's greatest men had little to exhibit outwardly that would indicate potential leadership. The differences in mental characteristics and abilities constitute one of the most difficult problems in teaching.

188. All Pupils Do Not Learn With Equal Ease and Rapidity. The effects of individual differences in ability to master skills, and in comprehension, may be seen by observing a group of learners in a shop, following an oral group demonstration. The teacher will find little to encourage him in the belief that his efforts have brought about uniform and maximum achievement.

The very best oral group instruction cannot produce uniform results, because of the wide variations in individual traits and needs. No two individuals have the same technic and in a large group there may be variations from near zero to a very high degree. There are differences in ability to form proper percepts, images, and ideas; there are differences in comprehension of

[10] A. I. Gates, *Elementary Psychology*, The Macmillan Co., 1925, pp. 503-509.

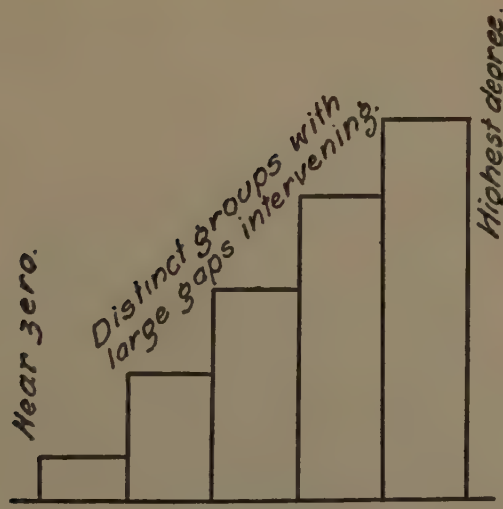

FIG. 10. Diagram to illustrate the distribution if mental and physical traits could be divided into sharply separated or distinct groups.

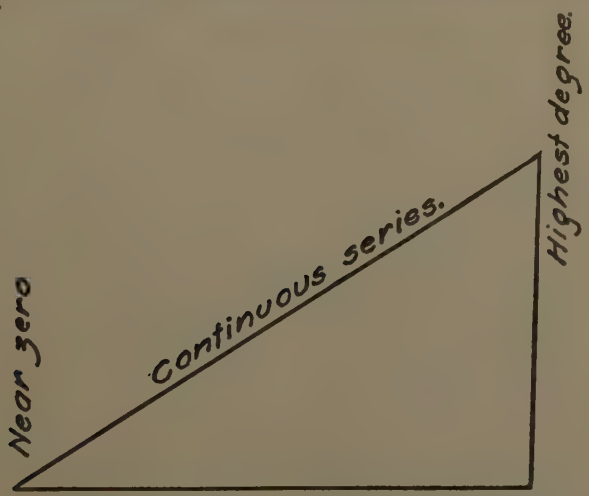

FIG. 11. Diagram to illustrate the actual distribution of mental and physical traits.

the details of the demonstration, and in subsequent attempts of the learner to apply the instruction given by the teacher. Test results also show differences in comprehension of related information. The same teaching to different learners produces entirely different results. In view of this, we must keep clearly in mind that all pupils do not learn with equal ease and rapidity, and that, so far as possible, we must provide every pupil an opportunity to develop to his highest capacity.

189. Group Instruction. Individual differences are recognized as common characteristics, but we have generally proceeded on the theory that there are sufficient likenesses in mental ability to justify group instruction. Apparently it is more economical to give instruction to an entire group at one time than it is to give instruction to the individuals of the group separately. Economy, however, must be measured in terms of what we get as compared with what we spend. Considered from this standpoint, group instruction is not economical. Slow learners either condition the progress of the remainder of the class, or are neglected by the teacher as real participants in the instruction. Fast learners are permitted to lag, or they are assigned supplementary problems which often are disliked, as they suggest punishment rather than reward for good work. Mischief often tempts the fast learner even when he has been assigned supplementary problems to keep him busy. The learner soon comes to the conclusion that he is doing "extra work for no pay," and lagging and mischief follow.

Group instruction does not take into account the problem of individual differences.

The following description is typical of conditions in a shop class of 20 boys: After the first demonstration and oral instruction, the teacher finds that a few of the boys understood the demonstration and instructions and are doing the work correctly. The remainder of the class are having difficulties, no two of which are alike. To meet this situation the teacher begins follow-up instruction by repeating parts of the demonstration, and by suggestions to various individuals. The slower members of the group require several minutes of attention and, judging from their reactions in applying what they thought they had seen and heard, there is clear indication that the whole demonstration must be presented again. Perhaps the whole method of presentation needs changing in order to meet the needs of this part of the group. If the change is made, however, it probably would not meet adequately the needs of the other members of the class.

There are many reasons why there are various kinds of reaction to a demonstration, but the underlying difficulty is that it is practically impossible to provide for the wide range of individual needs and abilities in one demonstration. Differences in sense of touch, sight, hearing, energy, emotions, and in reasoning, are only a few of the factors involved in such learning problems, which make necessary a great variety of stimuli if we attempt to meet the needs of all the class at one time. It may be necessary to repeat the demonstration, or parts of it, several times, and even then there will be wide differences in understanding as well as in results.

190. Project Grouping. Project grouping has been attempted in the shops, just as ability grouping has been attempted in academic instruction, but the results have not been satisfactory. The selection of projects, and arrangement into several groups of varying difficulty, has been the most common practice. They are so chosen that all of the projects in a group involve essentially the same skills and content, and the same demonstrations of tool processes or construction problems will apply to all of them.

One plan has been to arrange three parallel groups of projects, each group having the same teaching problems. The first group, however, contains larger and more difficult projects which only a bright individual can complete in the time allotted. The second group consists of projects of average difficulty, the completion of which by an individual of average ability would require the entire time of a given course. The third group consists of rather simple projects which a dull individual probably would complete in the allotted time. Theoretically this method may be satisfactory, but in application it does not function as well as its proponents expected. After the first demonstration, uniform group progress cannot be maintained, and individual instruction becomes necessary.

Another plan of grouping which has been advocated by many is illustrated by the following extract from a bulletin for accredited schools, issued by the University of Missouri, in 1909:

WOODWORKING

In the outline, given below, the work has been arranged in groups. Each group contains a number of problems involving the same processes. The arrangement provides for the uneven progress of the class, and the teacher is able to keep all members of the class engaged on the same type of work, although working on different objects. A number of supplementary exercises should be provided. The student may be permitted to make almost any object which involves the processes or principles of the group in which the class is working. The subject-matter is indicated under the heading "Processes."

GROUP I. Giving the first use of the saw and the laying-out tools, such as gage, try-square, and rule.

Processes: Measuring, squaring, gaging, sawing, boring, making dowel.

Problems: Game-board, counting-board, laundry-list, puzzle, etc.

GROUP II. Emphasizing the first use of the plane.

Processes: Planing—surface, edge, to dimensions, chamfering.

Problems: Swing-board, hat-rack, bread-cutting board, etc.

GROUP III. Teaching the first use of the chisel.

Processes: Vertical chiseling, gouging, paring, sharpening chisel.

Problems: Shelf and brush-rack, tray, sleeve-board, etc.

GROUP IV. Involving "form-work," and the first use of the spoke-shave.

Processes: Bow-sawing, modeling, sandpapering.

Problems: Coat-hanger, tool-handle, canoe-paddle, etc.

GROUP V. The construction of objects by means of some form of the groove joint.

Processes: Housing, halving, nailing, carving, finishing.

Problems: Waterwheel, test-tube rack, book-rack, flower-pot stand, loom, sled, box-trap, bracket-shelf, knife-polishing board, towel-roller, etc.

GROUP VI. More exact work in planing in order to make a glue joint.

Processes: Planing joints, gluing, clamping.

Problems: Bread-molding board, drawing-board, bench-hook, etc.

GROUP VII. Construction by means of the mortise-and-tenon joint.

Processes: Laying out duplicate pieces, cutting a mortise, sawing a tenon, finishing.

Problems: Stool, plant-stand, taboret, umbrella-rack, table, etc.

GROUP VIII. Construction involving the miter joint.

Processes: Planing parallel edges and sides, use of miter-box, laying out brace.

Problems: Miter-box, framing a picture, box, bracket, etc.

GROUP IX. Elementary cabinet-making, involving the use of panel.

Processes: Plowing, fitting, putting on hinges.

Problems: Sewing-cabinet, music-cabinet, plate-rack, screen, book-case, etc.

Such arrangements are helpful but they do not place the repetition where it is needed. The bright individual needs less repetition than the dull one, but in this plan the bright individual gets the repetition which the dull one needs but does not get. Our problem is to permit the learners to achieve at their best rate rather than to attempt to get them to learn equally or to keep them together.

Classification according to ability in academic procedure may appear to be more successful than project grouping in the shop, but that is because the academic work is more intangible. In shopwork there is no opportunity to conceal failure or to "bluff through." Ability grouping in academic classes, and project grouping in shop classes, may alleviate the conditions, but will not solve the problem of fitting instruction to individual differences.

191. Individual Oral Instruction. Individual oral instruction may provide, theoretically, for individual needs, but it is more wasteful of time and energy than group instruction. It is a very difficult task for a teacher to meet the needs of a large class through in-

dividual oral instruction. At best, many of the learners are neglected, and energy and costly materials are wasted because of the inability of the teacher to distribute his time so as to give instruction to the individual pupil when he needs it.

192. Combination of Printed and Oral Instruction. The use of written instructions as an aid in overcoming the difficulties arising out of individual differences has given highly satisfactory results. Teaching a single lesson effectively requires a combination of forces acting together in order to provide converging stimuli on each individual. Individual instruction-sheets, well written and wisely used, together with well presented group oral instruction and individual oral instruction, provide a variety of stimuli which to a considerable degree fit the instruction to individual differences. The problem may never be solved with entire satisfaction, but the combination of written and oral instructions is the most satisfactory method yet devised.

193. A Fundamental Error in Teaching. Failure to make a clear distinction between skills and problems has been a very common and fundamental error in all teaching. This common error has been responsible for much of the difficulty encountered in meeting individual learning problems. Proper selection, organization, and presentation of content are the basis of all good teaching, and they must be made with this distinction clearly in mind. The instructional units must be selected on the basis of what the student must know and must be able to do in order to solve the problems in the field for which he is preparing. The skills must be taught to the learner by the teacher; they cannot be left to

accidental discovery, or discovery by trial and error. They are exact habits, and must be developed according to the laws of habit formation.

The problems must be solved through thought and reasoning, and this involves a method quite different from that required in developing skills. In their anxiety to develop initiative, many teachers fail to distinguish between these procedures. They expect the learner to acquire the skills through experimentation, or to solve his problem by muddling through rather than by any definite plan he has worked out. Thus the whole learning situation becomes confused. This great fundamental distinction is the stumbling-block in the way of all good teaching in the shop, and any form of instruction devised to meet the problem of individual differences must begin at this point. It is the first step in the improvement of teaching, and all well written instruction material observes this distinction.

194. Importance of Reading. Reading is an ability common to most learners, and is essential to school progress as well as to advancement in the world outside. Many learners are able to read, and to comprehend written directions as well, or even better, than oral directions. The use of written instructions provides for this type of student additional stimuli which reach and exercise other traits that are of value in learning, and provide a means of independent progress. The greater the variety of stimuli, the greater the probability of meeting individual needs and abilities.

195. Written Instructions Not a Handicap. Written instructions have a decided advantage for the slow

learner. He may read and reread the directions and, with an occasional oral suggestion from the teacher, may eventually comprehend them. There may be differences in the rate of reading and comprehension, but written instructions are not momentary as oral instructions are, and the time required for learning is no greater.[11] Oral words begin to fade and disappear as soon as uttered, but printed words remain forever, and can be scrutinized for meaning and referred to when needed.

196. Definite Units of Instruction an Aid in Providing for Individual Differences. In shopwork the fundamental operations are the principal units of instruction. This is true whether we use the oral demonstration or written instructions. If a class is to be taught as a group, it can be taught more effectively by using a combination of oral and printed instructions than by the use of either alone. It must be remembered, however, that written instructions are designed to provide for individual progress. In group instruction, where a combination of oral and group instructions is used, each member of the class should be provided with instruction-sheets, and the teacher should perform all the demonstrations by following the written directions step by step as they are read by a member of the group. The pupil then has the written instructions at hand as a reference to be reread when needed. The teacher should aid in clearing up difficulties by giving individual attention if found necessary. As the class separates in accomplishment, as it will on account of individual differences, the instruction-sheet can be

[11] See Chapter XVIII, Comprehension of Printed Instructions.

relied upon more and more, thus enabling the teacher to give more individual attention where it is needed. There will be differences in rate of progress and accomplishment, but individual abilities will not be neglected, as they are when oral instruction is relied upon entirely. The slow learners will not accomplish as much as the fast learners, but both will have learned and acquired skills and related information to a greater degree than through oral instruction. This procedure is recognized as the best means of coping with the problem of individual differences.

197. Grading and the Normal Curve. The chief purpose of grading is to attach satisfiers or annoyers to the work of the learners. After a teacher has graded at least several hundred individuals, it will be found that the grades tend to fit the normal curve; see Fig. 9; about 3 per cent will receive very low grades; 22 per cent, low; 50 per cent, average; 22 per cent, good; 3 per cent, excellent. The variations within each group on the scale will be gradual from the lowest to the highest. These grades may be in per cents, or in letters, or in numbers. The per cent plan represents a minute differentiation that seems impossible to administer fairly because of a number of external factors, such as the kinds of tests, the attitude of the teacher at the time of the grading, and many other factors that exert an influence directly or indirectly.

It is obvious that grading based on the finer divisions involves a certain amount of error. It is more fair to the learner, and to the teacher, to give the grades in larger units, and thus to reduce the probable error in-

volved. To say that a learner is in the *B*-group probably is more nearly correct than to say he earned 85 per cent. The "*B*" represents a distance on the normal curve that includes the 85 per cent, together with a few points above and below to account for the probable error due to a large number of chance conditions. The learner who gets an 85 may be entitled to an 87; to give him a *B* would place him in a group where a slight error in our estimate would not be an injustice to him.

Letters or numbers representing grades vary in school systems, but five divisions are generally used with the letters *A, B, C, D,* and *F,* each representing a division. *A* is excellent; *B* is good; *C* is average; *D* is passing; *F* is failure. If grades for a large number of students in a given class are examined, it will be found that they tend to fit the normal curve, with *C* representing the average or 50 per cent of the individuals graded.

This does not mean that grades should arbitrarily be made to fit the normal curve. The smaller the class the greater the probability of injustice in attempting to fit grades to the curve, because some courses may attract brighter individuals than others, or due to chance conditions, a group of bright, or dull, individuals may be enrolled in a given course. It must be made clear that the curve does not fit the measurements; but that, in large numbers of cases, the measurements tend to fit the curve. It is merely a graph used to convey the information that, due to laws of chance, mental and social traits, as well as natural phenomena, tend to be distributed in certain propor-

tions. However, it does enable an individual to discover how effective his teaching or how accurate his grading has been by examining his grades for a large number of students with relation to the normal curve. Should it be enlarged too much to the right, it may mean laxity in grading or a tendency to give tests that are too easy. Should it be enlarged to the left, it may mean low grading or a tendency to give tests that are too difficult.

198. Summary. There are differences among individuals with respect to the majority of human characteristics. Heredity and environment are causal factors. They affect the most minute part of the human mechanism, and neither mental nor physical characteristics are free from their influence. This fact suggests a tremendous problem which teaching methods, based on oral group instruction, do not take into account, nor do they provide for any adequate solution for the difficulty. Habits of failure, half-done work, shirking, and working below one's capacity are inevitable results of group instruction. A great number of traits are brought into use in a learning situation, and the greater the variety of stimuli provided for each individual the greater the probability that he will learn to his fullest capacity. The solution of the problem of individual differences is not one of getting all pupils to learn equally, but rather to give instruction in such a way that each one will develop to his full capacity. A combination of group oral, individual oral, and printed instructions is the best means of providing a variety of stimuli that will enable each learner to achieve to his own limit.

199. Observation Problem.

Assignment: Go quietly into the class assigned to you. Take necessary notes and make a written report for conference covering the following points:

1. What method of instruction is used? Does it provide for each learner to go at his own rate and to his capacity?
2. Observe all the learners, and note the progress made after a demonstration. State the differences in achievement as you see them.
3. Does the teacher attend to each individual, or is time too limited?
4. What distinctions were made between the methods used in teaching skills and those used in solving problems?
5. What is the basis for the units of instruction?
6. Plan a procedure that will give every learner the opportunity to advance according to his ability.

QUESTIONS—CHAPTER XIII

1. What are the chief causes of individual differences?
2. List a number of environmental factors that influence individual learning ability?
3. How does the problem of differences affect classroom procedure?
4. Why is it impossible to get all learners to achieve equally?
5. What results can be expected by applying the same instruction to two individuals who, we shall assume, are alike?
6. In what respect can reading ability control an individual's progress?
7. Plan a method of procedure for coping with individual differences in the shop.

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CHAPTER XIV

Intelligence in the Shop

200. School Leaving and School Teaching Problem. Intelligence is a factor which must be considered in any form of instruction whether oral or written. It is as important a factor in the shop as it is in the academic classes. The type of work or the method of teaching does not change the general effect of intelligence.

Many problems of discipline and learning have been attributed to instinctive activity, typemindedness, lack of interest, and other causes, when they might better have been accounted for by a clearer understanding of the problem of intelligence and individual differences. Low intelligence, and the resulting inability to get along well, lead many children to leave school, especially near the end of the grammar-school period when they have passed the age of compulsory attendance.

Attendance reports computed from the Biennial Survey of Education, U. S. Office of Education, show that in the United States, out of an average of 100 pupils in the fifth grade, 87 continue to the sixth, 77 to the seventh, 66 to the eighth, 55 enter high school, 26 complete high school, and only four complete the college course of four years.

Undoubtedly there were a large number of chance causes for this school leaving, but failure probably is the most inclusive factor; it embraces a large number of causes. An examination of data in

Table 1[1] shows that intelligence is one of the most potent of these causes, and that it is of greater significance than is realized by many teachers.

School Grades	*Scores*	*College*	*Scores*
4	23	Freshmen	128
5	41	Sophomore	137
6	53	Junior	141
7	71	Senior	145
8	85		
		Graduate	157
9	97		
10	111		
11	122		
12	127		

Table 1, showing median intelligence scores for 17,090 cases taken from the Army Alpha Manual.[2] Note the decided increases in the score at successive school levels. Large numbers of those who leave school from time to time are of lesser intelligence, and the median scores for the remaining students are thus increased.

Success is satisfying and failure is disheartening. It is annoying for the dull pupil to meet failure after failure; and as success ceases to be a factor, school life also becomes annoying, and the desire to leave school develops. A process of self-selection takes place,[3] and he soon withdraws from competition with those who are brighter, and finds some consolation on the street or in industry where the competitors in his field are

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[1] *Statistics of Universities, Colleges, and Professional Schools, 1925-26,* U. S. Office of Education, Washington, D. C., Bulletin 1927, No. 40, p. 19.

Biennial Survey of Education, 1924-26, same, Bulletin 1928, No. 25, p. 576.

[2] *Army Alpha Manual of Directions,* Sixth Edition, Bureau of Educational Measurements, State Teachers College, Emporia, Kansas, 1928, p. 16.

[3] G. H. Betts, *The Mind and Its Education,* Third Edition, D. Appleton & Co., 1923, p. 261.

nearer his intellectual level and his rewards are equal to theirs.

Experimental evidence and careful observation of practice have led to the conclusion that the theory of instinctive activity and inherited typemindedness are less important factors in learning than intelligence. The tendency in modern teacher training is to minimize the theory of controlling the instincts, and of developing them into capacities; and it is generally conceded as doubtful whether a child may be a born mechanic, or a born this, or a born that. Intelligence undoubtedly is a far more important factor.

201. Nature of Intelligence. Psychologists have not agreed on a definition of intelligence. They seem to have agreed, however, that it is ability to learn by means of the higher intellectual processes; that it is ability to do abstract thinking, to form analogies, to build up hypotheses, and to solve problems.[4]

The following fundamental considerations of intelligence may help to explain certain facts in discussing the problem. It will be noted that several of these statements have been borrowed from the discussion of individual differences in Chapter XIII, because a consideration of both problems must involve human traits and abilities as influenced by heredity and environment.

1. An individual is made up of many traits and abilities;[5] mental, physical, emotional, temperamental,

[4]F. N. Freeman, "What Is Intelligence?" School Review, XXXIII, April, 1925, pp. 253-263.

[5]E. L. Thorndike, *Educational Psychology*, Vol. III, Teachers College, Columbia University, New York, 1914, pp. 366-387.

sensory, motor, attitudes, habits, character, knowledge, information, ideas, ideals, and many more.

2. All people possess in some degree all of the known human traits.[6]

3. People differ in the degrees in which they possess these traits. In nearly all traits the nature of the differences is such that for a large group of people they follow the normal curve.[7]

4. People differ not only in the degrees that they possess human traits, but the traits are organized differently in different people.

5. The nature of the organization of traits for a group of people is such that nearly all relations between all measured traits is positive. Between some traits this relationship is high, and between others it is low.[8]

6. These traits are probably not born in individuals, any more than are severed limbs, but the potentialities for their development, however, are born in all normal individuals.[9]

7. Experience is an important factor in the development of these traits. Through experience they may be strengthened and through lack of experience they may be weakened.[10]

8. All individuals probably are born with potential

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[6]B. R. Buckingham, "Intelligence and Its Measurement," Journal of Educational Psychology, XIII, May, 1921, pp. 271-274.

[7]E. L. Thorndike, op. cit., Chapter XIV.

[8]Ibid., pp. 360-362.

[9]S. S. Colvin, "Principles Underlying the Construction and Use of Intelligence Tests," *Twenty-First Year Book,* Public School Publishing Co., Bloomington, Illinois, 1922, pp. 17, 18.

[10]A. I. Gates, *Psychology for Students of Education,* The Macmillan Co., 1924, p. 208.

levels of capacity to which all these abilities or traits may be developed.[11] This potential level is said to be the level of intelligence. It is not inborn; we have only the capacity to reach this level.

Let us consider these points briefly. An individual does not inherit one ability or particular trait, but a multiplicity of potential abilities and traits. These traits vary in degrees among individuals, and the degrees of variation depend upon inheritance and the kind of environment experienced, beginning early in infancy. Early home and school life are very important factors in the ultimate development of the individual. This is recognized in the increasing number of nursery schools in recent years. Those who encourage them believe that the development of human traits can be controlled more effectively by beginning early.

It is also believed that individuals inherit abilities which will enable them to attain some degree of success in anything for which they are trained, provided the training begins early in home and school life. This is significant for shop teachers as well as for academic teachers. One may probably become an equally good carpenter, printer, or teacher, but he must begin his training early, and learning situations must be attended with successes. There are inherited differences in physical traits, which will enable some people to do better in certain lines of work than others. For example, an individual with short, stubby fingers, would be handicapped in attempting to play the violin or

[11]H. H. Goddard, *Human Efficiency and Levels of Intelligence,* Princeton University Press, Princeton, N. J., 1920, pp. 1-8.

piano. One whose vocal organs favor a soprano voice would be seriously handicapped in attempting to sing bass. And likewise other physical characteristics control development of certain traits and abilities.

Ideals of success and failure also are important in one's development. The extent of achievement depends upon intelligence plus favorable experience and much work.[12] Human traits and abilities are not born in individuals ready to function, but individuals are born with potentialities for their development. The level to which these traits and abilities can be developed is limited to the degree of intelligence of the individual. Training, then, is limited to the learner's level of intelligence. These levels vary in all individuals from near zero, in continuous gradation, to a very high degree. There are no single characteristics peculiar to intelligence. The multiplicity of human traits and abilities, their manner of organization through experience, and the potential level to which they may be trained, all contribute to one's ability to learn.

202. There Are Many Intelligences. While intelligence is often thought of as a general capacity which enables one to form analogies, set up hypotheses, and solve problems, this idea is not contrary to the belief that we possess many intelligences and not just one. The kind and amount of experience, beginning early and continuing through life, determine the number and kinds of intelligences one may possess. But any par-

[12]W. H. Pyle, "The Relation of Ability to Achievement," School and Society, XXII, September, 1925, p. 408.

ticular kind of intelligence must have for a basis general intelligence. For example, a specific intelligence may be acquired in mechanical engineering by providing proper experience for one who has good general intelligence; he builds up an engineering intelligence from engineering experience. And so may medical intelligence, law intelligence, teaching intelligence, electrical intelligence, and so on, be built up. Any of these various fields of activity may consist of specialized branches which in themselves require special intelligence. The electrical engineer who specializes in generators develops a specific intelligence to the exclusion of other kinds of intelligence which might have been developed in the electrical field. It must be clear, however, that any specific intelligence must begin with general intelligence. The amount of any individual's particular intelligence depends also upon the degree or amount of general intelligence with which he started.

203. Manifestations of Intelligence in the Shop. Individuals who possess a high potential level of intelligence achieve more, under favorable conditions, than those who possess a low level. The more intelligent possess ability to make adjustments to a greater number of different situations. This includes ability to carry on under unfavorable circumstances, and to increase the ability to form analogies and solve problems. The less intelligent individuals are characterized by ability to react to only a few situations. They are narrow and restricted; greater and greater drill is necessary and the tendency to give up is more notice-

able.[13] These are some manifestations which may be observed in all life situations. Shop teachers who have made sufficient observation have observed the variety of responses, and methods of making them, by pupils in adjusting themselves to new problems. Manifestations are not the same in all individuals. However, the most significant of all manifestations is the ability to overcome difficulties and to make adequate adjustments.

Difficulties, or problems, are encountered in the shop as well as in academic activities. For example, a pupil in the shop is faced with a situation which requires a change of construction in order to overcome a change in design. The less intelligent is more likely to need the assistance of the instructor in overcoming the difficulty than the more intelligent who has had an equal amount of training. The student who is continually needing assistance, and is dependent upon his fellows and the teacher, is probably the less intelligent. Of course, we have exceptions in individuals who are lazy or physically unfit. Laziness probably is a more important factor in learning than we generally suppose.

204. Degree of General Intelligence Required in Shopwork. As shop teachers we are concerned with the ability of our students to get along well and to succeed in the shop. General intelligence is required of individuals in the shop as well as in other pursuits of life. The degree of success attained depends upon the intelligence of the individual and his efforts. It is true

[13] Rudolph Pintner, *Intelligence Testing,* Henry Holt and Co., 1923, pp. 55, 56.

that a dull individual may get enjoyment and pleasure in the shop, provided he is not too carefully observed by the instructor and ideals of success are overlooked. The dull pupil is more easily satisfied, his work is crude and generally commonplace. When attempting to plane, his success is mostly in producing shavings; it is success to him, and success is satisfying. He has satisfied the ideals as he knows them in his world.

But satisfaction in this sense is not real success from the teacher's point of view. The pupil is getting along and may be happy and satisfied, but he is really not achieving as we know its meaning. Any pupil in order really to achieve and solve problems in the shop, must possess a degree of general intelligence which will enable him to take advantage of his shop experiences and thus develop shop intelligence. As a rule, the pupil who can adjust himself well to academic experiences, other things being equal, adjusts himself to shop experiences, and vice versa.

205. Intelligence and Environment. Since all individuals are born with potential levels to which their abilities or traits may be developed, an important problem is suggested for the teacher. It means that experience, or environment, is an important factor in the development of these capacities to the highest level. The teacher cannot do much for the individual who does not possess at least mediocre potential intellectual capacity. The best possible training that money can provide will not lift above his level the unfortunate individual who has inherited a poor intellectual mechanism or has developed limitations after birth. Idiots, imbeciles, and morons are included in this class. How-

ever, the individual who fortunately possesses a high potential level must be provided with proper training or his capacities will not be developed to the highest degree.

We are confronted with problems of the individual rather than problems of the group in providing the instructional phases of environment. Group instruction presents difficulties with each individual. Since all people differ in the degrees in which they possess the various human traits, and since these traits are organized differently in different individuals, we are confronted with a very great variety of differences. A teacher does not deal with one total of mediocre ability in classroom procedure, but he deals with a large number of separate and varying abilities.

206. Development of Shop Intelligence. The duty of the teacher is to assist in developing shop intelligence in those individuals who possess general intellectual capacity. It is not a problem of accumulating knowledge or facts, but of providing shop experiences and shop problems so that the individual may become competent to meet and overcome world situations of a similar nature. In order to meet and overcome new shop situations one must possess shop intelligence.

Just as there are individual differences in physical traits, there are also differences in thoughts and in problems. Probably no world situation will ever be exactly the same as the school situation, so that accumulating facts and knowledge will be of little value unless accompanied by the ability to combine them in the solution of new problems. This means that the in-

dividual must do abstract thinking, be able to make abstractions, form analogies, and solve problems requiring many new combinations. This requires intelligence, and the kind of intelligence he has depends upon how he has been able to take advantage of and profit by past experience. There must be opportunity to do abstract thinking, form analogies, build hypotheses, and solve new problems.

207. Comprehension and Instruction. Difficulties arising from the use of oral instructions and well-prepared printed instructions may often be traced to the problem of intelligence. A large per cent of world success is dependent upon linguistic abilities. The ability to deal with symbols or to interpret facts from the printed page is a common requirement for those who desire to get along with their fellows and succeed in world activity.[14] Written instructions offer one of the best means for training the mechanic in these things which will contribute so much to his future success. The learner must possess at least fair general intelligence in order to interpret the written instructions. Likewise, the learner must possess at least fair general intelligence in order to understand oral instructions.

In fact, written instructions may be even more desirable than oral instructions for the dull pupil. More opportunity for intensive study is possible with written instructions, whereas oral instructions are but momentary, and remain only in the memory of the one

[14]F. A. C. Perrin, and D. B. Klein, *Psychology,* Henry Holt and Co., 1926, Chapter VI.

who receives them. It must be perfectly apparent that the dull pupil is slower and more inaccurate in comprehension than the bright one, and that his memory of what he apparently comprehends is not as good. Each of these deficiencies presents serious difficulties in oral instruction, and the combined effect makes some other method highly desirable. Written instructions are much more effective and should be encouraged. They are in a permanent form, ready for individual use when needed, and may be scrutinized at any time, and as often as necessary, to get a clear understanding of the instructions. On account of these features they provide an excellent means of coping with individual differences in learning.

208. Intelligence and the Exploration Theory. Since there probably is no inherited typemindedness,[15] and since intelligence, favorable experience, and much work are important factors in education, we should be rather cautious about accepting theories which encourage the use of shop subjects entirely for exploratory purposes. It is unwise to assume that an individual may be a born carpenter or a born teacher, and that he must explore through experiences until he finds himself. Experience accompanied by the satisfaction of success is important in one's development, and satisfaction may be found in a great variety of experiences. The Law of Effect operates in all life situations, and satisfaction is one of the effects we desire.

Building proper ideals that lead to success is a far more important problem for the young man, who seeks

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[15]E. L. Thorndike, *Educational Psychology,* Vol. III, Teachers College, Columbia University, New York, 1914, Chapter XV.

to prepare for the future, than exploring until he finds what seems to be the work for which he is fitted. Exploring in a few subjects will not provide experiences which will enable all the known traits and abilities to function. Any sort of exploratory experience must be broad and of sufficient amount to build and test one's ideals for achievement, and the shop courses usually offered for this purpose fall far short of this requirement. Proper ideals leading toward success must accompany efforts to choose or prepare for an occupation. The boy who aspires to become an engineer must possess a high degree of general intelligence and ideals leading to success. Without these, he cannot become a successful engineer.

209. Mental Testing. Mental tests may not be as valuable as some people believe, but teachers should take advantage of them in order to verify personal opinion and observations. All teachers should be interested in the testing program. Problem cases should receive the same careful study and attention of shop teachers that academic teachers and administrators give them. Since so many dull children are sent to the shops, it may be wise to study the problem from the intelligence point of view. Careful examination may verify personal opinion or reveal an unusupected condition which may aid in correcting an almost hopeless teaching situation.

210. Technic of the Mental Test. While it is impossible to include enough material in this Chapter to enable a student, in training for shop teaching, to become adequately familiar with mental testing technic, it is advisable to attempt a brief explanation of the termi-

nology of testing. Achievement tests are discussed in Chapter XIX.

The purpose of an intelligence test is to measure general intelligence. It is not intended that all known human traits and abilities should be tested separately, but that they should be measured as a unit in their existing state of organization. Traits and abilities are too closely interwoven to be singled out and measured separately. Nor would this be of any value, since none of these traits and abilities singly is typical of intelligence. They function as a unit in their varying degrees of organization.

It is believed by many who do not understand the theory of mental testing that it is rather mysterious, and that the test has been prepared by some genius in psychology who wrote the questions for want of something else to do. Nothing is farther from the truth. In order to construct a good mental test it is necessary to have the cooperation of a large number of individuals in careful experiments, and these results must be analyzed and checked with the most exacting care.

The tests do not measure intelligence directly, but only indirectly. Intelligence, like electricity, must be measured by its effect. Electricity is measured by its effect on a meter, so the degree of one's intelligence is shown by its effectiveness in making adjustments to certain typical situations.

Tests are usually made by assembling preliminary test questions in large numbers ranging from the simplest to the most difficult. These questions include "mathematical problems, verbal relationships, logical relationships, extent of vocabulary, various forms of

reasoning, and general information.'"[16] Just as chemists test *samples,* so are these tests applied to *samplings,* or large groups of children, who are representative of all children. Repeated *samplings* are taken and the scores recorded.

The scores must fit the normal probability curve. When certain questions are found that are consistently unanswered by all groups, they are eliminated. When results show extreme difficulties, or test scores are too heavily skewed toward the zero end of the normal curve, the questions are changed. Likewise, changes are made when the questions are found to be too easy. The tests are applied to children of various ages, and the averages recorded. When it is found that ten-year-olds, for example, make an average score of 70 after repeated tests, it is assumed that a twelve-year-old who makes the same score on the same test has a mental age of ten years.

This process of compiling the average scores of a certain test, and recasting the questions until results show a normal distribution, is a process of *standardization.* The average scores obtained from large samplings of children of various ages are recorded, and are called *norms.* A table of *norms* should accompany every test, so that the scores made by the individuals who take the test can be interpreted in terms of mental ages.

This describes briefly how tests are made, and shows that they are not merely chance selections but that they are scientifically prepared.

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[16] F. A. C. Perrin, and D. B. Klein, *Psychology,* Henry Holt and Co., 1926, p. 325.

211. Group Tests and Individual Tests Are Similar. The procedure just stated briefly describes the construction of group intelligence tests. The procedure for compiling the items of an individual test does not vary greatly from the above. The Terman revision of the Binet-Simon individual tests is recognized as the forerunner of all tests in America. It is used as a standard of comparison for all mental tests. The items of this test are so constructed that mental ages are derived directly without the use of point scores.

212. Mental Age and the Intelligence Quotient. Intelligence is based on the *mental age.* (M.A.). *Mental age* is derived directly from the test, or from the table of *norms.* If an eight-year-old child does the work, in a given test, which is expected of the average of a large number of eleven-year-old children, he is said to have a *mental age* of eleven years. A twelve-year-old who can only pass the test of a nine-year-old is said to have a mental age of nine years.

It is necessary to have some method of expressing the ratio between the two ages. This ratio is called the *intelligence quotient,* or I. Q. It is a quotient which indicates the amount in per cent that an individual is ahead or behind his chronological age at the time of the test. An eight-year-old child who has a mental age of eleven has an I. Q. of 137. The mental age is divided by the chronological age: $11 \div 8 = 137$. Likewise, a twelve-year-old who has a mental age of nine has an I. Q. of $75 : 9 \div 12 = 75$. A child whose chronological age is ten, and who passes the test for a ten-year-old, has an I. Q. of 100, which is normal. An I. Q. of 100 is always regarded as normal.

The intelligence quotient indicates how fast or how slow the child should learn. The child with an I. Q. of 137 should learn 37 per cent faster than the normal child with an I. Q. of 100. The child with an I. Q. of 75 should be 25 per cent slower than the normal child. The I. Q. is a prediction of the rate of learning, and means nothing more. It does not indicate how a child really does learn. There are a number of factors, such as illness, laziness, interest, attitude, emotions, which affect the final achievement of the individual.

213. Real Achievement Should Be Determined. A quotient which represents the real achievement of an individual with relation to his mental age would be of interest and of value. It is of far greater importance to know whether a child achieves up to his ability than to know what he should do. In order to determine how a child achieves, another type of test is necessary. The standardized achievement test is devised to measure results in the various school subjects. From these tests may be determined how a child compares with other children in achievement.

For example, a ten-year-old child who takes a standardized test in arithmetic may pass the test of the twelve-year-old level. He is said to have an arithmetic age of twelve years. Likewise, standard tests for all subjects may be taken, and *subject ages* determined. A composite of all the subject ages is called the *educational age.* A ratio between the mental age and the educational age, (E.A. ÷ M.A.), gives the *achievement quotient,* A. Q., or the *accomplishment ratio,* A. R. This quotient shows whether or not a child achieves up to his mental ability and is of far greater value than the

I. Q. as used alone. The normal A. Q. is 100. Children who are doing well in school usually have A. Q.'s of over 100. Those who are not doing well, who dislike work, who are ill, or who have not had opportunity to learn, have A. Q.'s under 100. From the achievement quotient the teacher is able to determine the individuals who really need attention.

A ratio between the chronological age and the educational age, (E.A. ÷ C.A.), gives the *educational quotient,* E. Q. This indicates how a child achieves generally according to his chronological age. Since all children of a given chronological age do not achieve alike, the E. Q. is not as significant for classroom work as the A. Q. Thus arises one of the problems of individual differences. Should all individuals learn at the same rate, there would be little need for the testing program or need for improvement in methods of teaching.

214. Summary. Intelligence is one of the important factors in real achievement in the shop. Difficulties are as common in the shop as in academic classes, and those who are not equipped at birth with at least potential mediocre intelligence are seriously handicapped in their efforts to do well in the shop. Those who can react to only a few situations, and who cannot form analogies and solve problems, present serious difficulties for the teacher. It is unwise for us to assume that our work as teachers is to substitute acquired reactions for native reactions, or to discover typemindedness, because intelligence is a factor that precedes these, and many similar problems. It should be remembered that the individuals with whom we work

are able to adjust themselves to some degree to the shop environment and profit by it.

Individuals vary in abilities, and the problems of the world vary in kind. Accumulation of facts and information, which may be learned by tedious memorizing, may be of little value in meeting new situations, unless the individual can turn these facts into the solutions of new problems in his field of endeavor. Whatever that field may be, the individual must develop a specific intelligence that has been built on at least a fair foundation of general intelligence. In the shop we are interested in developing shop intelligence. The shop teacher should be interested in the testing program.

QUESTIONS—Chapter XIV

1. Is it possible that certain physical handicaps as well as physical qualities may influence one's ability to learn? Illustrate.
2. How would observation of shop reactions enable a teacher to form a judgment with regard to native intelligence of the learner?
3. How would amount of drill in attempting to learn skills be an indication of ability to learn?
4. Is it probable that learning skills and reasoning about or analyzing jobs would be of equal difficulty for the less intelligent and the more intelligent? Give an illustration.
5. Which requires the greater mental effort?
6. In what respect are laziness and readiness factors to be considered with intelligence in our shop teaching problems?
7. Have you any reason for disappointment, after sufficient proof of mental condition by observation and test results, when you are unable to teach the simplest skills after a large amount of drill?
8. What is the value of printed instructions as compared with oral instructions when intelligence is considered?
9. Does it seem logical that, since ability to interpret symbols is an indication of intelligence, shop learning might be considered as dependent upon symbols?
10. What is Mental age? I. Q.? A. Q.? E. A.? E. Q.?

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CHAPTER XV

Reasoning

215. Reasoning is Learning Behavior. Reasoning is often described as a special kind of thinking, but the term "thinking" possesses so many meanings, and is so inexact as a descriptive term, that it is impracticable to attempt to describe the process of reasoning by the comparison of so called types of thinking. The product of thinking means more than the kind of thinking. We are primarily concerned with the fact that each learner should be able to make mental adjustments which will enable him to solve his problems. This may be called a kind of thinking, or a culmination of thinking, but our interest is in the mental reaction involved in solving problems.

Reasoning is a form of learning behavior in which the learner seeks to draw upon analogous experiences in order to solve a problem or to overcome a difficulty. It also may be called "mental trial and error." The learner explores the facts of his experiences, recognizes his new situation, and attempts to combine the new with the old. An hypothesis is set up and tested. It may be done mentally, or by manipulation, or by a combination of both. If it proves satisfactory, it is applied in the solution of the problem. Should it prove to the contrary, mental "trial and error" again take place, and the search for a solution continues.

During the reasoning process new combinations of neural routes are formed. Routes already formed through past experiences are combined with new im-

pulses from the stimuli of the existing problem. Trials are made in connecting the old routes with the new impulses until satisfactory connections have been made and the problem solved. For example, a student in drafting is often required to combine his past experience in orthographic projection, shop knowledge, and certain general principles, in order to select the proper views for a new drawing. Neural routes must have been formed in all phases of the work required for the selection of the views for the new drawing, or for the solution of the new problem. When these routes have been properly connected with the impulses from the stimuli of the new problem, a solution has been formed.

These connections are not always readily made because some of the older neural routes may not be well formed. The influence of disuse and the kind of inherited nervous mechanism may delay or inherit entirely the proper connections with new impulses. It is obvious, from the explanation of the changes in existing neural routes during the reasoning process, that experience is an important factor in insuring better opportunity for forming the neural combinations. Neural routes are not readily combined unless based upon experiences closely related. This explains why experience gained in one field of work may not be of any great value in solving problems in another field.

216. Reasoning the Basis of Progress. Progress demands ability in reasoning. The problems of life are not accompanied by the solutions, and the only way in which we can arrive at the solution is through the process of reasoning. It is, therefore, the duty

of the teacher to provide opportunity for experiences which will enable the learner to develop ability in solving problems in the field of work for which he is preparing. This means that a process of reasoning must be involved in teaching and learning. The teacher should guide the learner into recognizing relationships between the new and the old in forming analogies, setting up hypotheses, solving problems, and should always encourage him to form his own analogies and solve his own problems. If he needs assistance, his difficulty may be in his method or plan of procedure, and the teacher should endeavor to locate the difficulty and guide him in correcting it, but he should not solve the problem. This assistance is needed more often by beginners than by advanced learners. The advanced learner has had experiences that should enable him to form judgments more quickly and more exactly than the beginner. Teachers, therefore, need to observe beginners more closely in order to be sure that the basic operations are thoroughly mastered and a basis formed for the solution of new problems, or the planning of new procedures.

217. Need of Experiences. Providing problems through which to develop reasoning requires a knowledge of the probable past experiences of the learner. Analogous past experiences and related information are both necessary before one can proceed to the solution of a problem. A learner is quite helpless if assigned a task for which he has no adequate background in experience. He has no starting-point; nothing upon which to base an hypothesis. A teacher will

appreciate this situation if he recalls some of his own experiences.

Insufficient experience leads to failure. The learner who blunders or spoils stock in attempting a new operation does so because he lacks experience. As he builds up experience he ceases to spoil stock and thus overcomes his difficulty. Compare the novice in "trouble-shooting" on an automobile with the one who has had experience. The one with experience manipulates less and reasons more as he determines the difficulty.

It is important that the learner be taught the fundamental operations early in his training so they can be added to his background of experience for attacking new problems. The fundamental operations should not be considered as unrelated in themselves, but rather as the elements of larger tasks. The learner must be familiar with these elements in order that he may bring them together in combinations necessary to do the job. In making assignments, teachers must be sure that the learner is provided with these elements and that the work is not beyond his ability and experience.

218. The Problem-Solving Attitude. Experienced teachers know that the presentation of a problem to a learner does not give assurance that he will approach it with a problem-solving attitude. Merely presenting a problem does not mean that the challenge will be accepted. There must be an urge or impulse calling forth a desire to meet the difficulty and overcome it. A highly desired objective which involves a need for the solution of some problem in order that the objective may be attained usually is the best means of creating

the problem-solving attitude. A feeling of need sets up a state of readiness or desire to solve the problem. A learner who has already launched upon a series of successful problem-solving experiences usually is in a rather fixed state of readiness for attacking new problems, and requires only the challenge of the problem. The difficulty of setting up the problem-solving attitude, or a state of readiness, is greater during the beginning of a problem than at any other time. One must work at a problem enough to become interested in it. Once an inspiration is acquired, and attended with successes, the learner is launched upon a continuity of self-acquiring problem-solving attitudes. This is the ultimate learning condition desired by all good teachers.

219. Problems in the Shop. Skills and related knowledge in combination are required in solving problems. The related knowledge is the ideational learning, or the theories necessary in planning and in forming analogies and in setting up hypotheses for the solution of problems. The problems in the shop are the jobs. A combination of skills and related knowledge is necessary in order to do the jobs. Some of these skills and the related knowledge may be new and some may be old. Situations seldom occur in which all the elements in the combination are entirely new. Even in the first shop experience elements of past experiences influence the judgment in solving the problems.

The learner needs to plan his procedure in order that the various steps in doing the job may come in the proper sequence. This involves reasoning. For ex-

ample, if a learner is required to make a one-quart dipper of sheet-metal, it is obvious that he should have a plan of procedure, or job plan, in which each step is listed in the order in which he will do it. In the making of such a plan the pupil must determine why the steps should be taken in a certain order. The order of the first steps, such as "Making out the bill of material," "Laying out pattern on the stock," and "Cutting out the pieces," do not involve much reasoning, but there are many factors to consider in determining the order of the steps in making up the dipper. He must determine whether he will fold the seam before he forms to shape, or afterward. He must decide whether he will form the shape and solder the seam before he puts the wire in the top or turns the burr for the bottom.

The determination of the questions involves a knowledge of certain facts, and drawing conclusions from their consideration. It affords just as high an order of reasoning as mathematics. It is evident that it will be necessary for the teacher, at times, to assist by calling attention to certain facts or conditions that have been overlooked, and to assist in relating ideas and experiences in order to secure a satisfactory plan, but it is necessary to do so in mathematics, and any other subject involving reasoning.

Planning involves all the elements of the highest type of mental development, and the manifestations of ability to make these adjustments readily are more often found in bright individuals than in dull ones. In order to plan a job, it is necessary that the learner should reason, and he cannot do so unless he has analogous experience on which to base the reasoning.

It is important, therefore, that in the beginning the tasks should be simple and contain elements somewhat related to former experiences. Elementary skills and the ordinary every-day tasks furnish the basis for the beginner. With these as a basis, he may be taught to plan his problems from the very beginning.

220. Mental Adjustment in Forming Skills. Reasoning is also required to some extent during the process of imitation following the demonstration of a skill. The effort to make one's movements conform to the movements in the demonstration, requires some mental adjustment. Teaching skills by imitation is necessary, but during this process reasoning is not entirely absent. The reasoning, however, is not with respect to the skill, but as to how to perform the operation exactly as required. The "trial and error" involved in making the adjustments are part of the development of coordination between the head and the hands.

Learning to saw to a line requires some degree of mental adjustment. If the saw begins to cut away from the line, the learner must make comparisons of his situation with the teacher's demonstration, and determine what to do in order to correct the difficulty. He backs up; attempts short strokes; twists the saw back to the line; it pinches and sticks, and he must compare his efforts with the demonstration of the teacher, and try again. Perhaps a correction by the teacher may be necessary in order to connect the new motor experience more definitely with the mental experience of watching the demonstration. A process of reasoning takes place in which the learner makes abstractions and singles out the elements that make it

possible for him to saw to the line. Practice on these elements brings about skill and ease in performing the operation. The brighter individuals acquire these skills more quickly than the duller ones because they are capable of making the mental adjustments more readily.

221. Reasoning Ability of Children. Much has been written about the reasoning ability of children. We are concerned with the ability of those who are old enough to use at least the simple woodworking tools which, in many schools, begin with fifth-grade children. It has been a common belief that the ability of children to reason is very limited; that their activities are largely spontaneous; and that shopwork must be presented with a view only of accommodating these spontaneous actions. It is further believed by many that effort in developing reasoning ability in children is unwisely expended. These are merely theories, and experienced teachers believe that children do reason, and that they begin to reason very early in life. Provided with sufficient information or past experience, many of them can reason as well as adults. The difference between child reasoning and adult reasoning is a matter of degree, and it varies with the inheritance, ages and experiences of the individuals concerned.[1]

A child's reasoning, like that of an adult, may be limited by lack of experience. In most of our everyday affairs, however, an adult has accumulated experiences that enable him to form a wide range of judgments. The child has not accumulated these experi-

[1]F. N. Freeman, *How Children Learn,* Houghton, Mifflin Co., 1917, pp. 230-235.

ences and therefore he is handicapped by comparison in the accuracy and range of his judgments. Like the adult, he can reason within the sphere of his experience, but not beyond it.

Planning procedures in shopwork requires reasoning, and children can learn to plan them remarkably well when they are given opportuity to do so. Planning procedures is a common requirement in all activities of life, and fifth-grade boys are just as willing to participate in this practical phase of shopwork as they are willing to "build" railroads and caves and the like. Many play activities in which boys engage require careful planning. The difficulty in teaching boys to reason lies more in the unwillingness of the teacher to give them opportunity to reason, than in a lack of desire or ability on the part of the boys. Children can and are willing to plan procedures when they are encouraged to do so.

The development of elementary skills is necessary in order to prepare a basis in experience for reasoning in shopwork. While a child's perception or appreciation of skill is not as great as that of an adult, he is willing to develop skill up to his capacity. His capacity for development in shopwork is comparable with his capacity for development in other subjects. If he is capable of solving problems in arithmetic, he can also learn to plan a simple procedure in the shop.

We must consider all individuals as learning mechanisms subject to development by experience. The stimulus-response theory is effective from earliest childhood. If we desire certain responses we must provide appropriate stimuli. If we wish children to

reason in shopwork, we must provide situations which give them opportunity to reason, and require them to do so from the very beginning of their shop experience.

222. Summary. While reasoning is a form of thinking, it is not necessary to examine its various aspects in order to understand that it is a mental reaction necessary in solving problems. It is a form of learning behavior in which analogous experiences play an important part. Changing of neural routes into new combinations is necessary during the solution of the problem, and it is obvious that routes from widely related fields are not readily combined.

Progress accompanies reasoning, and it is the duty of the teacher to provide experiences which will enable the learner to develop ability in reasoning. There must be a process of reasoning involved in teaching and learning, and experience of the proper sort is necessary before the learner can proceed to solve his problems. In shopwork he must be taught the fundamental operations and related information because they are the elements from which shop problems are solved.

Learners are not always in a state of readiness to attack problems. The ultimate learning condition desired by all teachers is to get them into a problem-solving attitude. Once an inspiration is acquired, and accompanied by success, the challenge of the problem is often all that is required to attract the individual into further problem-solving. Skills and related knowledge are required to solve shop problems. The problems in the shop are the jobs, and their solution comes as a result of planning procedures. The learner should plan his procedures beginning with the first

shop experience. This should begin in the elementary grades, because children can and do reason.

Mental adjustments also take place during the process of imitation following the demonstration of a skill.

223. Observation Problem.

Assignment: Go to the classroom assigned to you, and make the following study. Report on your observation in conference.

1. How does the teacher conduct the work so that the learners have opportunity to reason? Give an example?
2. Observe a specific case in which the learner has been assigned to a job. How is he required to go about it?
3. Find a learner who has a good job plan, and ask the teacher if you can make a copy. Attach it to this paper.
4. Does the teacher give the learners too much assistance? If so, state in which part of the lesson it is done.
5. Study an individual who is learning an operation after reading an instruction-sheet, or after a demonstration, and determine if he is having difficulties. If so, what are they? Find out from the teacher how he ranks in class accomplishment.

QUESTIONS—Chapter XV

1. What is reasoning?
2. Does the task of the common laborer require much reasoning? Why?
3. How do you get pleasure out of reasoning?
4. Is there danger in giving the learner too much assistance? Why?
5. If you were encouraging the learners to reason, would you choose problems that are easy or difficult? Why?
6. What are the steps in the process of solving a problem?
7. How should a teacher organize the subject-matter in order to encourage a maximum of reasoning?

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CHAPTER XVI

The Basis of Interest

224. Interest and Society. Interest is a feeling which attracts the individual, or holds his attention to some material thing, idea, act, or other feeling. We may regard it as an inner drive, urge, or impulse to attend to an activity which will benefit the individual. It always precedes effective learning.

A learner who enters a class in shopwork is prompted to do so by numerous inner drives, such as curiosity, self-preservation, desire for success, social approval, or mastery. The course of study should be determined by what the educational authorities judge to be the demands of society. Many of these requirements are most exacting, and in order to carry on instruction successfully it is necessary to develop sufficient interest in remote ends to make the worker willing to do the present unpleasant and uninteresting thing in order that he may attain the ultimate goal in which he is interested.

It must be remembered, however, that interest is a factor determining method of presentation, not content. In order that there may be interest in the exacting tasks of the present, there must be a definite and much desired objective, and it must be clear that these exacting tasks contribute directly to the realization of this objective. The objective may be a useful article, a desire for skill, a desire for social approval, or any worthy accomplishment. The willingness to put forth effort and to make present sacrifices will be determined

by the intensity of interest in and desire for the objective, and the belief that these efforts will contribute to the realization of that end.

There are inner drives that are as powerful in diverting interest as those which prompt the learner to take up his tasks. Such drives as disappointment, avoidance, repulsion, fatigue, fear, shyness, and play often are responsible for difficulties in maintaining interest during a period of instruction. Keeping the learner interested, or wanting to learn, or in a state of readiness to learn, is probably the teacher's greatest problem. This is best accomplished by developing and maintaining in him a very strong desire for some worthy objective, and showing him the road he must travel in order to attain it.

225. Interest and Feelings. Interest has been described as a feeling which attracts or holds the mind's attention to some activity which it is believed will benefit the individual. An activity accompanied by a feeling of satisfaction is more attractive than one accompanied by annoyance. The annoying situation attracts attention, but the feeling is not wholly desirable; and there is a tendency to avoid it. Interest and the Law of Readiness are similar. When one is interested, he is in a state of readiness. The organism is ready to make an adjustment, and the synaptic conditions are favorable to the conduction of impulses arising from the new situation. When one is not interested, the organism is not ready to make an adjustment, and the synaptic conditions are not favorable to the conduction of new impulses. A state of readiness may be brought about by other than pleasant means, but a review of the

Laws of Learning makes it clear that the pleasant feelings are the most productive because the individual is attracted to them.

Individuals are interested in something all the time. They are always desiring and seeking the pleasant, and it is this feeling which often hinders as well as facilitates teaching. Teaching situations cannot always be accompanied by pleasant feelings. Once the learner develops an interest, the turn of events will control his future conduct. The urge or impulse toward success, approval, self-preservation, or what-not, presenting prospects of successful attainment, bring satisfaction and further interest. Prospects of attainment lead to determination to accomplish the desired end. It results in mind-set, and an individual may develop mind-set even in the face of difficulties because he knows that a feeling of satisfaction will be acquired through attainment.

226. Coercion Tends to Inhibit Interest. Interest may be aroused through coercion, but the results of such interest are not wholly desirable. An immediate competition takes place between the feeling of unpleasantness and the new idea for possession of neural routes. The new idea cannot be so thoroughly impressed on the learner when it is competing for a place in the mind's focus. The less the attention is divided, or the more fully the neural routes are given over to impulses for one idea rather than for several, the more impressive will be the new idea.

To require a learner to remain after school to complete a drawing when he is a member of an athletic squad is a form of coercion. His mind probably is set

on football and not on drawing. He is interested in drawing only to the extent that when the job is completed he will be permitted to leave or will have qualified for football. A minimum of learning takes place. A competition exists between two ideas, and the one that offers the strongest immediate personal satisfaction wins. In the meantime, neither receives the full attention of the learner.

Coercion may sometimes lead to effective results when used properly. The learner who tries to letter well in order to receive a good grade, or to qualify for athletics, may build for himself an interest in lettering that may be superior to the impulse which caused him to attempt it. He may gain early successes in that which appeared to him at first to be a difficulty; and these successes will be satisfying and lead to increased interest and further improvement. The teacher often can control such situations by seeing to it that opportunity is present for some degree of early success. When coercion is used, it should be accompanied by satisfaction gained through success or should offer prospects of success.

Wisely used, it may lead to interest, but it acts as an emotional disturbance and interferes with clear thinking. Such interest is not conducive to effective learning.

227. Interest Varies With Individuals. Interest varies in intensity with individuals. It may vary in a large class from near zero to a high degree. Some are limited and others are unlimited in ability to become interested in things. The kind of inherited nervous mechanism determines in some measure the degree of

interest. The individual who is dull tends to be less interested in problems; the lesser things of life have a greater appeal to him. Planning procedures and solving problems are of interest to the brighter boys, while the mere development of a skill or just doing something are of interest to the duller ones.

Methods of securing interest obviously must vary as much as the abilities of individuals. The problem cannot be overcome by attempting to secure the interest of a group, but rather by attempting to secure the interest of individuals. This is one of the problems arising out of individual differences and one of the reasons for encouraging individual instruction.

228. The Exercise and the Project. Abstract exercises and useful projects have been discussed in classes in methods since shopwork was first organized. Early shopwork practice was based on exercises, and later practice was based on projects only. The attitude toward both has changed in recent years. The advent of trade analysis as a basis for the selection of instructional material, together with wise economy of instructional effort and materials of construction, have increased the tendency to favor practice work along with the useful project.

All interest is derived from things that may in some way benefit the individual; the things that will give satisfaction. The disadvantage of the exclusive use of practice work lies in the fact that the learner has little opportunity to recognize personal gain. He is unable to see the relation of this work to his ultimate objective, or to generalize the knowledge gained so that it may be used in future conduct. However, the practice

work, when used properly, has an important value. It is far better to use a piece of scrap stock for practice in developing skill than to do the practice on a piece of stock which forms part of a project. It offers a better opportunity for concentration on the process without fear of wasting good material. For this reason practice work has a very important place in teaching shop subjects.

Interest will not be lost because a skill must be developed. All learners in all grades recognize the need for it. The boy in the grades can be made to recognize this to some degree even though his appreciation of skill is not equal to that of an adult. He is willing to develop skill to his fullest capacity if he sees that it is necessary in order that his job may secure approval from the teacher and from his parents.

When a given skill has been reasonably well developed on scrap stock, let this ability be used on the job. The learner, through the success and satisfaction gained by a better product, will learn the value of, and the need for, preliminary practice. The skill learned will have been generalized for him; he will not only have reacted to practice work but also to its application. Good teaching requires ability to present the importance of practice work to beginning learners so they will be willing to practice in developing a skill before attempting to apply it in a project. A good teacher can get a learner into a state of readiness to do many things.

The notion that students are interested only in articles they can use, is not justified. They may be interested quite as deeply, if with somewhat greater difficulty, in acquiring ability which will

enable them to satisfy more remote wants. There is not the least doubt that students may be deeply interested in acquiring skill if it is made clear to them that skill is necessary to their success. They will even take great pride in their skill when skill is held up to them as a worthy ideal. Pride in workmanship should be cultivated not only because of the satisfaction it gives the worker, but because there is no surer foundation of good citizenship.[1]

229. Interest May Be Transferred. Interest may be transferred from something already interesting to something which appears to be uninteresting. The student who is interested in becoming a teacher and who is also interested in children may assume that psychology is dry and uninteresting. But after beginning the study of psychology, he discovers that it enables him to better understand how children learn and how learning events can be controlled by the teacher. He becomes greatly attracted to psychology because of its practical value in making more interesting the originally interesting thing, the teaching of children. And so may many teaching difficulties be overcome. The interest in one thing may be transferred to another when certain elements which bear relation to the originally interesting thing are discovered by the learner.

An object not interesting in itself may become interesting through becoming associated with an object in which an interest already exists. The two associated objects grow, as it were, together; the interesting portion sheds its quality over the whole, and thus things not interesting in their own right borrow an interest which becomes as real and as strong as that of any natively interesting thing.[2]

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[1]Selvidge, R. W., *How to Teach a Trade,* Manual Arts Press, 1926, pp. 81-82.

[2]William James, *Talks to Teachers,* Henry Holt & Co., 1915, p. 93.

Instructional material must be selected with respect to the learner's past experience and ability in order that he may be interested. Interest developed originally in the beginning work will carry over to advanced work. Building interest as the work progresses is far more difficult than proceeding from something in which an interest already exists. If there is little or no interest in the beginning, it is probable that there will be little or no interest to transfer to advanced work.

Since interest may be transferred to other things, an interest in one thing will lead to an interest in another; interest grows. By building early interests, or getting the learner into a state of readiness early in his work, a sure foundation is formed for future interests that will grow and control in a large measure his future success. Objects of interest are often originally repulsive. The practical affairs of life are seldom interesting, but when they are connected with interesting things, or things that possess personal value to the individual, they become interesting. They grow into ideals, and achievement comes as a result of the ideals set up through growing interests.

230. What the Teacher is Expected to Do. The demands of society suggest that every learner should be taught certain ideals with respect to accomplishment. One of the teacher's problems is to build interests in acquiring these ideals. This means that instructional material must be selected with respect to the learner's past experience and ability so that some degree of success will attend his efforts in meeting new experiences. The learner should have some oppor-

tunity to realize that effort is productive and that idleness is not productive. He should learn that progress out in the world requires certain ideals, and that they cannot be acquired through ease or effortless activity. He must take his place in the world, and difficulties which are repulsive rather than interesting must be met with determination and desire for success.

The selection of instructional material also should be made so that the learner will know definitely what he is expected to learn. In order to do this, units of instruction must be selected which, when used in combination, constitute the steps necessary to do the job. Interest in mastering these units and applying them leads to success in the particular shop subject.

To hold the learner's interest, it is necessary for the teacher to maintain an atmosphere of deep interest in the work in which he is engaged. He should know and be able to do well the work he is attempting to teach—he should be a master of his subject. He should be able to take stock of his own knowledge of the subject in order that he may know what to teach, and he should know the fundamental principles of teaching shop subjects. He must become interested in individuals and individual instruction; because, after all, the interest problems lie in individual cases, and each individual is a separate study. A sympathetic teacher who has confidence in his own ability and faith in his students should soon create an atmosphere of interest.

231. Summary. Interest may be thought of as an inner drive, urge, or impulse to attend to a purposeful accomplishment which will benefit the individual. Hard work, wearying monotony, and ceaseless competition

await the learner when he enters upon his work in the outside world. It is the duty of the school to prepare the learner to meet and overcome these situations. The course of study is determined by the demands of society. In the shop, the learner is required to gain a mastery of skills, and ability to apply them intelligently. He should enter upon his vocation well prepared to meet its problems, and able to overcome them; he must know and be able to do certain things on completion of a course, and making what he pleases in any way he pleases certainly will not be of benefit to society or to himself.

When one is interested he is in a state of readiness, and this is brought about by pleasant rather than by unpleasant means. Individuals are always seeking the pleasant and avoiding the unpleasant, and sometimes this hinders as well as facilitates teaching, because learning cannot always be pleasant; it is often unpleasant, especially at the beginning. Once interest is aroused, the turn of events determines the learner's future conduct.

Coercion is not a satisfactory means for arousing interest because it acts as an emotional disturbance and clear thinking is inhibited. The new idea cannot be so thoroughly impressed upon the learner when it must compete for a place in the mind's focus. The less the attention is divided, the more impressive will be the new idea. While coercion may be used as a last resort, it should be used with caution and in such a way as to develop a situation in which it will not be needed.

Interest varies, and methods of securing interest

must necessarily be fitted to individuals. All interest is derived from things which will benefit the individual; the individual must gain satisfaction. The use of practice work is difficult because the individual cannot recognize personal gain in it. The useful project and practice work combined are needed in order to teach shopwork effectively. Skill should be reasonably well developed in practice work before it is attempted on the job.

Interest may be transferred from one thing to another, and, because of this, previous training and experience should be taken into account when instructional material is selected. Interest developed in the beginning work carries over to advanced work. The practical affairs of life are not always interesting, but ideals set up in school will aid in practical achievement. The requirements for good citizenship suggest that ideals of accomplishments should be acquired befor an individual enters upon his vocation. One of the teacher's problems is to build interest in acquiring these ideals. The instructional material must be selected so that the learner will have opportunity to know what he is expected to learn. The teacher must be master of his subject, must be able to analyze it, and must know the methods of teaching it. Individual instruction is advisable.

232. Observation Problem.

Assignment: Go into your observation room, select one learner for a study of the problem of interest, and make a written report, being guided by the following questions:

1. In what does the learner appear to be interested? Is he interested in the work he is doing? Upon what do you base your judgment?
2. Compare this learner's attitude with that of several other learners.
3. Are any factors apparently diverting his interest? If so, what?
4. What method of instruction is used?
5. How does the teacher maintain interest?
6. How are the teacher's confidence and ability reflected in the interest he maintains?
7. Is he businesslike, and does he create a generally wholesome attitude of interest?
8. Select another learner who seems entirely disinterested, and plan a procedure for arousing his interest.

QUESTIONS—CHAPTER XVI

1. What is interest? Explain how it is related to attention. What is the educational value of interest?
2. Explain how the Laws of Learning and Interest are combined in a learning situation.
3. What are the requirements of society for good citizenship?
4. Tell why emphasis on the successful part of a job will be better than emphasis on the errors.
5. How can coercion be used, if used at all?
6. What is the significance of individual differences in interest?
7. What is the value of practice work? How will you use it?
8. What is the teacher expected to contribute toward the building of ideals of accomplishment by his learners?

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CHAPTER XVII

The Transfer of Training

233. What is Meant by Transfer. Learning a thing in one situation and being able to apply or to use it in another is called "transfer of training." It is also called the "doctrine of discipline." It is a learning problem that concerns the shop teacher as well as the academic teacher. Since the days of extremely formal education, there have been differences of opinion with regard to this doctrine. One belief was based on the assumption that the mind is made up of fixed forms or faculties, and anything that exercises one of these forms renders it capable of applying the power thus gained to other things. Keeping a neat note-book in a school subject would train the learner to keep his dresser arranged neatly at home. The study of Latin would train the learner to analyze business problems. The study of language was required of those who would be educated because it was believed that it resulted in the development of a scientific intellect. A lawyer should study mathematics because mathematics involves reasoning, and a good lawyer must be able to reason well. These beliefs of the formalists were so sincere that each subject to them became education in itself, and they were satisfied with this assumed value. The belief in complete transfer still exists in some quarters, but it is not generally accepted.

234. Theory of No Transfer. With the advent of experimental psychology, there developed a theory that was quite contrary to this. It maintains that there

is no transfer of training; that training in one subject is of no value in another subject; that learning to reason in mathematics does not aid one in reasoning in business; that habits of neatness in school work do not necessarily lead to habits of neatness in dress. It maintains that education must be specific.

235. Transfer of Identical Elements. Observation of these theories as they worked out in practice led to some doubts as to their validity; but a critical study, together with much experimental evidence, has led to the conclusion that both theories are more or less correct. It has been shown that in so far as there are identical elements, and the student has learned them in one situation, there will be transfer of those elements to other situations in which their identity is recognized. Cancellation learned on formal problems in arithmetic would carry over and be an aid in solving board-measure problems in the shop if the element of cancellation in the formal arithmetic problem is recognized as identical with the cancellation involved in solving a board-measure formula. The attitude of analytical approach in solving mathematical problems develops a habit of analytical approach in attacking other problems, provided the learner has studied mathematics sufficiently to develop this method of attack as a general habit or attitude. The study of Latin helps in the study of English, provided the student recognizes that the technic developed in one is applicable to the other. Learning to cut a mortise on one job is an element that should carry over to other jobs in which mortises are to be cut because common ele-

ments are recognized. One who has developed a thoroughly established habit of planning his procedure before starting on a job is likely to do so in other fields because it represents a general habit of action when one is confronted with a problem.

These identical elements may be methods of procedure, subject-matter, or ideals and principles. In so far as they occur, and are recognized in more than one field of industry, the training in one situation will carry over into another. This means that effective teaching must develop the ability to use in new situations things learned in old situations. As shop teachers, we are concerned with the ability of our learners to use in advanced operations and jobs the knowledge, skills, and attitudes learned in beginning operations. In order that this may be done, however, the training must be practical, and the elements involved should be identical with the elements required in subsequent problems, and situations must be provided so that this identity will be recognized.

In order that the teacher may do his work effectively, there must be recognition of identical elements in the principles of teaching which he has learned and the teaching he attempts to do, and he must be able to relate the subject-matter he has learned to the subject-matter he proposes to teach.

236. Elements to Be Transferred Must Be Identified. The learner must be aware of the elements to be transferred, and he must have opportunity to exercise them, if the learning is to be effective. One of the difficulties which confronts practical tradesmen, who are placed in teaching situations without training, is their in-

ability to transfer trade skills and trade knowledge for use in teaching situations. It is necessary that the elements to be transferred be abstracted by analysis. In order that these elements, or skills and knowledge, may be recognized readily, they must be reduced to their simplest forms. Combination must be avoided in the analysis, because, when these elements are combined with other elements, transfer of the whole group results, and the single elements are not recognized. Since there is no fixed or rigid relationship between the elements as they are combined in various situations, it is unwise to learn them in a fixed relationship. This represents a very serious objection to the use of the job as a unit of instruction. Flexibility in the combination of elements is important, but it is possible only when the elements in the analysis of the trade or subject are recognized as common elements in various situations.

Once a tradesman, or teacher, has analyzed his subject-matter into its simplest teaching units, he will have little difficulty in recognizing the identical elements of the trade or subject for use in a teaching situation. Until it is analyzed properly, it remains a rather mysterious and formidable body of material, and effective teaching cannot take place because the elements to be taught are not recognized as common to both situations.

237. Teach the Thing in the Way It Is to Be Used Later. Grave danger lurks in methods of teaching, and particularly in the training of teachers, if the learner is not given opportunity to develop the specific skills he will need in his future work. Teachers

are called upon frequently to give demonstrations, and they should be given training which will enable them to give these demonstrations with such skill and ease that their handiwork becomes an inspiration and an ideal to be followed by members of the class. This means that the use of machines must be carefully avoided during the beginning courses in teacher training. Skill in the use of tools cannot be developed without much practice.

The use of jigs also should be avoided until the learner reaches that phase of his training which requires production methods. Skills should be taught in the way in which they are to be used, because we learn only those things to which specific reactions are made. If one desires to learn to saw a board accurately and squarely, so that he can demonstrate the process, he should learn to do it by hand without the aid of the miter-box or other guide.

The use of copy drawings in attempting to train draftsmen is an example of failing to teach a thing in the way that it is to be used later. Neither a draftsman, nor any other learner, trained in one way should be expected to react in another way on the job. He will react to a given thing only in the way in which he has learned to react to it. This suggests that the use of "crutches"[1] or special aids should be avoided when it is desired that a particular skill should function eventually without them; anything that must be unlearned before the real thing can function should be avoided.

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[1]A. I. Gates, *Elementary Psychology,* The Macmillan Co., 1924, p. 461.

238. Transfer May Be Negative and Thus a Hindrance. Learning a thing in one situation and being able to use it in another is positive transfer. Learning a thing in one situation so that it will be a hindrance in another is negative transfer. An individual who has learned to do the slanting Gothic style of lettering will be hindered when changing to a vertical architectural style. The habit of slanting the Gothic letters leads to a tendency to slant the vertical architectural style and thus render it less artistic. Attempting to change from the "hunt-and-peck" method of typewriting to the touch system is another example of negative transfer. The habits of watching the keys rather than the copy, and using two fingers rather than all the fingers, are transferred, and seriously hinder the learning of the new system.

The danger of negative transfer should be understood by the shop teacher. It means that faulty habits are as readily formed as good habits and when they persist, they carry over and become a hindrance in forming better habits. Negative rather than positive transfer takes place when habits are not properly formed. The greater the laxity in forming proper habits in beginning work, the greater will be the difficulty in forming the required habits in advanced work. Our problem is to encourage learners to form new and better habits by providing sufficient opportunity to form them.

239. Differences in Individuals Cause Differences in Transfer. Individual differences affect the degree of transfer which takes place. Individuals vary in their reactions. Some react in an entirely satisfactory man-

ner, while the reaction of others is near zero. This suggests that in oral group instruction grave difficulties are presented. Instructions which secure favorable reaction from part of the group may fail entirely with other members. The individual oral instruction given following the group oral instruction does not eliminate the difficulties because economical distribution of time is not possible. Learners are often neglected because the weaker ones cannot be readily singled out and given proper attention, and the stronger ones cannot proceed at their own rate. Individual instruction-sheets, properly written and wisely used, are of great value in promoting transfer when used in combination with oral instruction. Training in the element of reading for technical purposes, which is included in the use of instruction-sheets, is also valuable because of its importance in outside world activity.

240. The Habits Desired Should Be Known. There is little transfer of good habits unless the teacher knows exactly what habits he wishes to develop and proceeds with care in developing them. A visit to a junior high school woodshop led to the following observations: A variety of projects were in evidence, and no group demonstrations of learning units were attempted. There were 22 pupils in the class, and many were needing attention and were demanding it. There was confusion, and the problem of discipline was increasing. There was little teaching, and little learning; it was a matter of keeping the boys busy. The teacher did not have in mind any specific habits he wished to develop in the boys. He was simply helping them make things. This shop is typical of many to be found

throughout the country. Only bad habits can result from such experiences.

241. Methods of Teaching Must Be Carefully Selected. The distinction between skills and problems, or operations and jobs, and the methods by which they are taught, is another factor which affects the possibility of transfer. Skills must be taught so they can be used in solving problems. In the shop we are confronted with planning procedures for the solution of problems. The jobs are the problems. Shopwork outside of school demands ability to plan procedures or to reason out problems. The planning of procedures in training is an attempt to prepare the learner to meet these practical situations. New problems are frequently encountered, and an individual may possess a high degree of skill, yet he may not be resourceful in the application of his skill to new problems unless he is trained in methods of attacking and solving them. The problem of the shop teacher is to teach these two fundamental things so there will be transfer.

242. Interest. Interest in the problem-solving attitude, in overcoming difficulties, in developing skill, and in attaining success, is necessary in order to insure transfer. Interest, attended with success in attaining a desired objective, is satisfying and creates further interest and further success. Feelings of satisfaction promote learning, and learning is necessary to get transfer.

243. Need of Meeting Practical Situations. In order to teach a lesson effectively, the teacher should be guided by the fact that transfer of identical elements from the old into the new situation is desired. New

school problems and new world problems are awaiting the learner in the future.

The development of skills and the planning of jobs demand special care in order that they may be readily used in other situations. Skills must be taught, but they must be taught in relation to jobs so that other situations in which they occur may be recognized. As previously mentioned, it is not uncommon for shop teachers, as well as academic teachers, to proceed on the theory that skills should be discovered or acquired by experimentation. This is a fundamental error, based upon a lack of understanding of the essential character of skill. A learner would be a long time in learning by chance how to cut a mortise correctly. The important thing for him to learn is how to cut it quickly and effectively, and to be able to recognize situations in which it is needed. Planning is the phase of the work that should be left to the learner; new problems should be solved by him, not for him. The recognition of new relationships between old ideas and facts and new ideas and facts is essential in problem solving or planning of procedures. There must be transfer of this ability to form analogies and to discover relationships, and the planning of procedures provides training for it.

244. Summary. Transfer of training concerns shop teachers because there are values which must be transferred as a result of learning shopwork just as there are values in other subjects. There have been differences of opinion concerning the exact values transferred in all subjects. At first it was believed that everything is transferred; later it was believed by

many that nothing is transferred. The present belief is that identical elements only are transferred, and then only when recognized as identical elements. The work of the experimental psychologists tend to confirm this.

In order that transfer may take place, the elements involved should be identical with the elements required in subsequent problems, and their identity must be recognized by the individual. The elements learned by a student in the principles of teaching must be identical with those he must use in the teaching he expects to do, and he must recognize the identity in the new situation.

It is necessary to analyze and recognize the elements to be transferred. These elements must be reduced to their simplest forms in order to avoid confusion. Until properly analyzed, the trade or subject is rather mysterious and formidable to the learner.

A learner cannot be expected to learn a thing in one way, and later to react to it regularly in a different way. If certain reactions are desired, instruction must be provided so that these reactions will be secured. Teachers frequently are required to give demonstrations, and their previous training must be such that they can give these demonstrations effectively. This means that skill in handwork must be emphasized in training. Aids and devices of various kinds which are designed to serve as "crutches" should be avoided because they become a hindrance to the desired reaction. Learning a thing in one situation so that it becomes a hindrance in another is called negative transfer. Faulty habits, like indolence or low standards of workmanship

learned in beginning work, becomes a hindrance to the subsequent development of better habits.

Individual differences affect the amount of transfer that takes place. The methods of teaching are also factors that affect transfer. The subject-matter must be so organized that the desired skills are readily recognized and easily taught. The teacher must be guided by the fact that transfer of identical elements is desired and that these elements must be recognized. Experiences must be generalized to as great a degree as possible.

245. Observation Problem.

Assignment: Before observing in the room assigned to you, plan a complete new scheme for conducting the class described in the illustration on page 336. Transfer (apply) what you have learned from various lessons and observations. Write out and hand it in with your report on your observation. Make your observations, and answer the following questions:

1. Is there successful teaching?
2. On what do you base your opinion?
3. Are the learners using operations that were learned at some time in the past without assistance from the teacher?
4. Is the instructor teaching the operations, or are the learners required to discover them?
5. Are the operations applied in jobs?
6. List several points that indicate to you that there may be transfer.

QUESTIONS—Chapter XVII

1. What is the doctrine of discipline?
2. Compare the old views with the present view of transfer.
3. What is meant by the statement that there can be no learning without transfer?
4. What is the significance of the statement that a thing should be taught in the way it is to be used later?
5. Why should learners be taught to plan procedures?
6. How will negative transfer seriously handicap shop progress?
7. How is the statement that skills must be taught, and not learned by chance, justified?
8. What is the value of a correct analysis?

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CHAPTER XVIII

Comprehension of Printed Instructions

246. Oral Instruction Habits. Certain mechanical difficulties are presented in the use of printed-instructions, such as: (1) Habits developed through oral instructions; (2) Reading habits established in earlier training; (3) Careless word selection in the preparation of printed material.

A sufficient amount of the right experience results in habit. One is said to be eye-minded or motor-minded because the habit of being eye-minded or motor-minded has been established. An individual who is habituated in certain ways of doing things is annoyed by, and avoids, suggestion of change. The individual who has been working in a shop for a number of years is not necessarily type-minded because it is difficult for him to give attention to a language. Shopwork is a habit, and he is annoyed by change from such work and is satisfied when applying himself to it. The Law of Effect operates to make him satisfied with his present habits and to cause him to resist change.

Group oral instruction which has been in use for so long as the prevailing type of instruction has provided sufficient experience to develop fixed oral-instruction habits. To be required to read and execute from written directions is annoying to the individual who has a habit of learning entirely from the oral instruction of the teacher. He may try to avoid the use of such instructions, or he may, in the beginning, become confused and be unable to comprehend them. It is quite

probable that, if individual differences had been recognized and individual printed instructions had been used in the beginning of the shop movement, there would be just as vigorous objection to any change from that plan.

Habits are not easily changed. An individual is prone to avoid suggestions of change unless he is convinced that his efforts toward it will be profitable to him. Shop teachers, however, need to recognize that recent developments in the organization of subject-matter through analysis make possible more effective methods of individual instruction. The increasing importance of industrial training, especially in public all-day and part-time schools, suggests that in preparing instructions more care should be given to equalize the effects of individual differences. Group teaching does not take into account the differences in ability, in comprehension, and in rate of learning. Shop teachers of experience, especially in part-time schools, find that effective group instruction is impossible.

247. Reading Habits. Improved methods of teaching academic subjects suggest means for overcoming some of the difficulties involved in individual differences. The principles underlying silent reading may be helpful to those who attempt to use printed forms of instruction for the first time. Poor reading habits established at some time in the early training of the pupil, before he comes to the shop or the drafting-room, are responsible for many of the difficulties which arise in the first use of printed instructions. The use of the instruction-sheet involves a type of reading which requires comprehension, and offers one of the

best and most practical means of developing or determining that ability.

The importance of proper training in reading habits should be recognized by industrial teachers. It is not proposed that they should establish reading classes, but they should know that poor reading habits constitute a serious handicap in shopwork as well as in academic subjects. One should investigate the reading habits of a pupil who is making unsatisfactory progress before assuming that inherited type-mindedness causes the difficulty in comprehension. A pupil trained in silent reading should have little difficulty in reading and comprehending instruction-sheets. If he is not so trained, the teacher should be patient and tolerant, but steadfastly insist that he develop the habit.

248. Aims of Silent Reading Realized in Using Instruction-Sheets. Silent reading is recognized as a means by which individuals are enabled to study. The individual who can acquire and interpret ideas from the printed page has mastered the first and most fundamental step in his progress toward independence. Fortunately, it is an ability which can be learned, but it is dependent upon intelligence and proper training. While those interested in the teaching of reading have been revising methods with a view to more efficient instruction, their aims cannot be realized unless they receive the cooperation of the teachers of other subjects. The little gained through formal training in proper reading habits, with subsequent neglect in application, is very small. It is much like formal English courses in colleges and secondary schools which leave the habits imperfectly established, and the student re-

turns to his former environment and reverts to his old habits. Ability to read effectively results in a better trained mechanic, and a more efficient mechanic. It adds to the possibility of his progress. The use of instruction-sheets should be encouraged as a practical means of training.

249. Comprehension Is Fundamental. While training in articulation, correct pronunciation, and proper modulations is highly important in oral reading, these accomplishments are not important factors in securing information from the printed page. One is seriously handicapped when first attempting to use instruction-sheets if his training in reading has been primarily for expression. Printed instructions, however, offer opportunity for training in the comprehension of factual material which is an important factor in success.

The two principal kinds of material encountered in reading are narrative and factual. Narrative usually is easy to read and comprehend. It is a form of stimulus which requires little abstract thinking; it is reading for sensation. It is the kind of reading done by the general public, and usually provides a means of entertainment. Factual material is less easy to read and comprehend, and it is the type of reading generally neglected in training and by the general public. It requires abstract thinking and the use of the higher thought processes. It is a form of reading which the engineer, physician, teacher, lawyer, or high-grade mechanic must be able and willing to do in order to make progress. It is the only means by which the door of scientific research and development may be opened. The training acquired through being required

to obtain some of his instructions through reading is of great value to those who seek success in mechanical lines. When a youth is confronted by a problem, he knows that the instructions needed in the solution are available, he has the strongest possible motive for developing the ability to comprehend factual material, and it affords opportunity to develop the habit of recourse to that kind of material when assistance is needed.

Discrimination comes with comprehension and at least fair native ability. In factual reading the individual must be able to discriminate facts of major importance from minor ones and thus form proper percepts. It enables the individual to make his actions conform in every essential particular to the ideas gained from the printed page. The reading of narration does not provide this training to the same degree.

Speed in comprehension is important as a means of meeting the competition of one's fellows, and it enables one to do a greater amount of work. Usually the less intelligent an individual is the slower he will be in comprehension and in the use of printed instructions. Factual material is difficult, especially for those who are not accustomed to it. Words must often be judged for shades of meaning, and repetition is required from time to time in order to carry through an idea. In well written instruction-sheets, dealing with skills, each statement carries an idea which, when read in conjunction with the remaining statements, forms a larger idea or learning unit. Speed in comprehending the meaning of these word combinations depends upon previous training, extent of vocabulary, and retentive

ability. Experience in using printed instructions enables the individual to develop these abilities better and more quickly, so far as shop instruction is concerned.

In reading instructions one must be able to carry the idea from the printed form to the actual performance of the intended meaning. In order to do this he must also carry the idea from one statement to another until the meaning of the whole is clearly understood. This is called retention, and the individual who comes to the shop trained in this particular ability has received training in the better reading methods. There is danger that the individual who apparently reads well orally, but who recognizes and pronounces words without fully grasping the idea or being able to carry the meaning as a whole, may be handicapped in the use of written instructions until he has developed better habits of reading. This ability can be developed by training, except in the case of individuals who have limited intellectual capacity. It is a combination of the ability to comprehend and to remember.

In order to grasp an idea in factual reading, and to apply it in a practical situation, reasoning is necessary. It involves the ability to comprehend, to discriminate, and to retain ideas while attempting to succeed in following the required directions. When the directions or other factual reading matter leads to success, interest is formed; together with an appreciation of the value of similar reading material. However, if printed instructions are to function as effective reading material, they must be carefully planned. The use of printed instructions when well prepared, establishes a habit

which leads to future growth, because it provides a means of study.

250. Reading Influenced by Intelligence. Comprehension of written instructions may be affected by intelligence, since intelligence is necessary in order to grasp any form of instruction whether oral or written. If a pupil cannot understand oral instruction because of deficient intelligence, he certainly cannot grasp written instruction, and vice versa. One advantage of written instructions lies in the fact that they remain and can be read and reread, and are thus better for those who are slow in comprehension, while oral instruction, once given, is gone forever, except what little the hearer retains in memory. The loss of oral instruction varies inversely with the intelligence of the learner.

In continuation-school work this is more significant than it is in the regular school. A process of selection takes place at the school-leaving period which, because of a variety of circumstances, seems to eliminate many of the individuals of less intelligence who must later attend continuation schools. Of course, there are exceptions; but the majority is quite likely to be found on the lower end of the scale of intelligence.

Poor reading habits are often accompanied by inferior intellectual abilities, which suggests that extreme care must be taken in the preparation of material for instruction. Since good intellect is necessary for comprehension of oral instructions, as well as for printed instructions, the choice may be in favor of the latter, if well written, because they can be used again and again by those who are slow in comprehending.

They can regulate the speed of instruction to suit their capacities; they can repeat difficult directions; and supplement difficult directions with the oral assistance of the instructor. The brighter pupils also have the added benefits of being able to proceed as fast as their comprehension and work limits permit.

251. Word Selection Deserves Careful Attention. Those who write instruction-sheets must take into consideration the probable reading habits and the intelligence of those who will use them. Publishers of books for young people are becoming more and more critical in the selection of words by their authors. Manuscripts receive the most careful scrutiny for difficult words. If this is important in the preparation of text material for young people, it certainly deserves the most careful attention of individuals who write instruction-sheets. The content should be based upon the pupil's level of experience, the words within his range of comprehension, and both completely and definitely organized for the purpose of doing a definite thing.

Experimental work in academic subjects has brought out some very significant facts for teachers with respect to the selection of words. It has been found that certain words are often too unimportant and too difficult to be given a place in the learner's reading. The tendency in oral as well as in written instructions is to use words that are beyond the range of comprehension of the young learner. Since oral instructions are not in permanent form, it is difficult to determine what words used are beyond the comprehension of the student. The words cannot be scrutinized as they can

be in written instructions to determine the cause of difficulty.

All industrial teachers are aware of the fact that many of their pupils have limited vocabularies. Words that are little used in every-day life, as well as special technical words, are not always fully understood. In some instances, substitutions should be made in favor of words in more common use. In the case of technical words substitution is not always possible, and hence care should be taken that they are fully understood. The best way of detecting words that are too difficult is to examine the instruction-sheet after it is written, comparing the words about which there is any doubt, and to make substitution when doubtful if such substitution can be made without loss of clearness. Technical words for which there are no substitutes should be used and their meaning made clear to the pupils.

Thorndike offers a list of 10,000 words, giving their importance and frequency of use.[1] By checking with this list one can readily detect words which may be doubtful when used in instruction-sheets. For example, along with a number of others, the following assignment-sheet was checked carefully for doubtful words and compared with the Thorndike list:

ASSIGNMENT-SHEET

HOW TO CALCULATE BOARD MEASURE

Information:

(1) A board foot in a piece of wood 1 inch in thickness, 12 inches in width, and 1 foot in length.

[1] E. L. Thorndike, *The Teacher's Wordbook.*

(2) Boards less than one inch in thickness are always calculated and paid for as if they were one inch thick. For example: A board ¾ inch by 12 inches by 12 inches contains one board foot. Also a piece ¼ inch by 12 inches by 12 inches is equivalent to one board foot.

When the stock is over one inch in thickness the additional thickness is taken into account. For example: Stock 1½ inches by 12 inches by 12 inches contains ½ more than a board foot, or 1½ board feet.

(3) The following formula gives an accurate solution of any problem in board measure:

$$\frac{\text{Thickness in inches (never less than 1 inch)} \times \text{Width in inches} \times \text{Length in feet}}{12} = \text{Board feet}$$

or $\frac{T'' \times W'' \times L'}{12} = \text{Board feet}$

Illustrations:

(1) What is the board measure of a piece of wood $\frac{1'' \times 8'' \times 10'}{12}$?

By cancelling and clearing the formula we have 6⅔ board feet.

(2) What is the board measure of a piece of wood ½″×8″×10′? In this case ½ is considered as one inch. Substituting in the formula, we have $\frac{1'' \times 8'' \times 10'.}{12}$ By cancelling and clearing the formula we have 8⅓ board feet.

Your job:

Calculate the following problems, using the formula and the table:

(1) How many board feet in a piece of oak 1″×5″×12′?

(2) How many board feet in a piece of pine 1″×11″×20′?

(3) How many board feet in six pieces of oak, each 1″×7″×12′?

(4) What is the cost of a piece of walnut 1″×5″×8′, at 30 cents per board foot?

(5) What is the cost of a piece of pine 1″×10″×18′, at 15 cents per board foot?

(6) What is the cost of a piece of pine ½″×6″×14′, at 12 cents per board foot?

(7) What is the cost of 15 pieces of plywood, each $\frac{1}{8}''\times18'\times4'$, at 6 cents per board foot?

(8) How many board feet in $2''\times4''\times10'$?

(9) What is the cost of six pieces of oak, each $1\frac{1}{4}''\times8''\times10'$, at 25 cents per board foot?

Some words found in this assignment-sheet appear without inspection to be in frequent use; they should be readily understood by the average learner. However, the word "equivalent" is not as common as one might assume. In a vocabulary of 7200 words, it is ranked in the last 600 for importance and frequency of use. The word "equal" is ranked in the first 1000. This means that the word "equal" should be substituted for "equivalent," in order to assure a better chance for success in comprehension. The word "additional" is ranked in the last 500 of a 5000-word vocabulary. The word "added" is ranked in the first 500, and would be a more satisfactory word to use. The word "illustrations" is also ranked low, and should be replaced by the word "example," which is of more frequent occurrence. There are 16 words in this assignment-sheet that are probably too difficult to be clearly understood by the average ninth-grade or continuation-school pupil. Substitutions should be made when possible, or, as in the case of technical words, care should be taken that they are clearly understood.

252. Technical Words Should Be Clearly Explained. It was found that certain technical words in the assignment-sheet are not in the Thorndike word-list. The word "formula," used three times, is not in the list. The word "decimal" occurs very infrequently. Such technical words cannot be changed without altering the

meaning, and it is desirable that they be retained. The indications are, however, that they may not be understood, and that their meaning should be made clear to the average part-time or ninth-grade pupil.

The vocabulary of a part-time pupil is probably not over 4000 words, and care should be taken that words commonly found only in a larger vocabulary are not used in writing instruction-sheets. It is even more important that the words in oral instruction are within the comprehension of the learners. Printed words remain and can be studied by the pupil; spoken words cannot be studied. If a teacher cannot prepare an instruction-sheet so that a pupil will understand it, it is probable that he cannot succeed any better by oral instruction.

253. Summary. Oral instruction habits, poor reading habits, and the use of difficult words in the preparation of instructions, are factors that must be taken into account in attempting to use instruction-sheets. More emphasis must be given to habit in cases of suspected typemindedness. If we recognize that many difficulties are caused by habits of doing things in the wrong way, we have taken an important step in the solution of our difficulties. We are annoyed at the thought of changing old habits; we hesitate to break them and build new ones. We do not like the thought of changing old ways of teaching, but we shall be compelled, sooner or later, to strengthen our methods to better provide for individual differences. Improving written instructions by careful preparation and word selection, and using these instructions effectively, is probably one of the best means of attaining this end.

QUESTIONS—CHAPTER XVIII

1. What is meant by type-mindedness?
2. What is the Law of Effect?
3. How does oral reading differ from silent reading?
4. Give your arguments for supporting either method of reading.
5. How can intelligence be an influence in the use of printed instructions?
6. Why would low intelligence be of greater significance in part-time schools than in all-day schools?
7. Get a copy of the Thorndike wordbook, or some other wordbook, and check several instruction-sheets for probable word difficulties. Assume an eighth-grade level, which is about a 4000-word vocabulary.

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CHAPTER XIX

Measuring Results

254. Introduction. It is generally agreed that results of teaching in industrial subjects can be measured, and that we must measure them if the subjects are to remain in the curriculum. We have emerged from the belief that there is "nothing to measure" in the shops, or that the learner is "tested every day" by the teacher's observation of the work, or that the measuring tools in the shop are ample for measuring achievement.

Efforts have been made at various times to construct tests for the shops, but they have not been altogether successful because of the lack of organization of instructional material. A test of any kind must measure progress in the subject-matter, and without progressive organization of subject-matter, little can be expected of attempts to measure.

A number of good tests have appeared in recent years, but they have not attracted the attention they deserve, nor have they been used as much as they should be. This probably is because of the attitude of doubt concerning attempts at measurement held by those who are unfamiliar with its aims and its methods. Another factor undoubtedly is the fact that the average shop teacher has been busily occupied with routine duties, and has not had time to devote to the study of tests and the methods of testing.

This Chapter discusses: (1) the purpose of testing; (2) the kinds of tests; (3) the construction of tests;

and (4) gives a brief description of tests now available.

255. Purposes of Testing. The purposes of testing are:

1. To present objective standards to the pupils.
2. To measure pupil achievement.
3. To improve teaching.
4. To diagnose pupil difficulties.
5. To compare one class or one school with another.
6. To provide guidance data.
7. To provide promotional data.

256. Presentation of Objective Standards. The use of tests removes from the minds of the learners all doubt that certain objective standards of achievement are required in a given course. There may be a number of reasons for the presence of individuals in a class, but they are often without appreciation of the important aims of the course. The necessity of complete knowledge of the content and mastery of skills is not always apparent. It is well for the learner to know that at a given time he will be tested in what he is expected to know. It is an excellent form of coercion which can be used with a minimum of emotional disturbance. The learners themselves will agree that the class work of the nonexamining instructor is often neglected, and that more time is given to the work by the instructor who holds them to account by examining them. Tests of some kind are necessary in order to encourage progress.

257. Measurement of Pupil Achievement. Tests are the means by which the results of a pupil's achievement in a given course can be evaluated. With the exception of planning procedures and the oral recitation, no other means are available for evaluating results in

ideational learning. The measurement of skills must be obtained by performance tests as well as by everyday applications. The tests determine the extent of the functioning of the Laws of Use and Disuse during the progress of the course up to the time of the test. The amount and accuracy of the knowledge and skill retained will be in proportion to the amount and effectiveness of instruction and the drill obtained during the course. This knowledge and skill can be determined by requiring the learner to react to selected questions, and to perform selected skills, which sample in some degree the instructional units of the course. These results are recorded, and comparisons are made during the progress of the course, in order to secure an objective record of achievement.

258. Improvement of Teaching. Tests also measure the efficiency of method, of the organization of subject matter, of attempts to diagnose pupil difficulties, and of the teacher's general influence. Improvement in any of these phases constitutes improvement of teaching. The method of presentation may be at fault. This may be indicated if the scores made in the test are all low. New methods may bring noticeable changes in the general scoring. When improvement is noted after the change of method, it is rather conclusive evidence that a change was desirable. If improvement is not noted, the difficulty may be in the test.

The analysis and organization of subject matter also may be at fault. The use of complicated instructional units affects the test results. The lack of definite instructional units of any kind, which is common in many shops, is certain to lower the test results. This

also tends to develop indisposition towards testing. Improvement in the selection and analysis of subject-matter will inevitably result in better teaching.

Test results also enable the teacher to determine pupil difficulties and peculiarities, so that remedial measures can be applied where needed. The teacher's influence in promoting general interest in the work and in gaining the learner's confidence in his ability is also a factor which deserves an important place in the improvement of teaching. Improvement of teaching should be followed by improvement of pupil achievement, which will be evident in the test results.

259. Diagnosis of Pupil Difficulties. This is a problem arising out of individual differences, emotions, attitudes, feelings, interest, reasoning, and the like. The program of testing is most worthily functioning when it is used for diagnosing the learning difficulties of each individual. The use of tests for this purpose offers a rich and constantly growing field of endeavor for those who are interested in teaching. It makes possible fair treatment for every individual, and is one of the most valuable devices for adequately determining the needs of each individual in a given course. The value of tests in this field alone should encourage shop teachers, as well as academic teachers, to use them.

260. Comparison of One Class or School With Another. Testing the results of instruction is one step toward the standardization of instructional units in shop courses. At the present time newer methods of selecting subject-matter are enabling shop teachers to define units that will provide eventually a means of standardization. Determining results by means of

standardized tests in shopwork makes possible a comparison of one shop class with another in the same school, or in other schools, if all class work is based upon the same units of instruction. It also permits comparison of one kind of shopwork in one city with the same kind of shopwork in another city.

261. Guidance Data. Tests provide information with respect to abilities and disabilities of the learners. Continued failures in particular subjects should obviously indicate that a learner is not properly making connections. The cause must be located, if possible; and when remedial measures have been applied, and have failed, it is probable that the school can do little for him in that subject. Mental test results may verify achievement test results, and the opinion of the teacher, and thus determine the cause of failure of remedial measures. One who consistently fails in a given course should not be encouraged to enter an occupation which requires an accurate knowledge of that subject.

To expect achievement tests to reveal undeveloped tendencies is to expect the impossible. Tests are based on definite units of instruction which must be experienced. The success of this experience shows in the test results. Undeveloped tendencies require proper experience for development. Following the necessary experience, the tests may be used, and it is in this manner that significant guidance data may be secured.

262. Promotional Data. Tests are used to discover the status of an individual in a given subject at the time of the test. It enables the teacher to compare one learner with another in order to find those who are fit

for promotion, or, to discover the degree of achievement in those things which must be known and done in a given course, and to determine who are entitled to attempt the next step in their educational progress. So long as promotion depends upon accomplishment, tests will be of value in determining and recording it. The tests used must measure accurately the things they are supposed to measure in order to indicate the extent of achievement.

263. Kinds of Tests. Three kinds of tests are in more or less common use:

1. The essay-type test.
2. The informal objective test.
3. The standardized objective test.

264. Essay-Type Test. Each of these tests has its advantages, and may be useful in some level of instruction. The essay-type is easy to construct and easy to give. The questions cover parts of the course as determined by the teacher, and the learner is required to write the answers. The subject-matter in the course can be controlled entirely by the teacher, but correcting and scoring is tedious and inaccurate. Opinions of the teacher, influenced by many chance conditions at the time of the scoring, such as, the teacher's attitude and varying degrees and kinds of feeling, neatness and arrangement of the paper, spelling, past record of the learner, and others, result in unfair estimates of achievement. Chance conditions are also responsible for the variety of written answers that often determine more or less the attitude of the teacher while scoring. A number of experiments have been conducted that show wide discrepancies in grad-

ing written examinations.[1] The written examination has led to a general attitude of getting something over to influence the teacher into giving a grade. The spirit of real learning seems to be lacking.

The essay-type tests require a longer time to give, and are restricted in the amount of the course that can be covered in the usual examination period. Ten questions that require writing will take the time of a class period, whereas the same class period may be of sufficient length for a list of 50 questions if no writing is required.

The essay-type tests usually are graded on a percentage basis. The highest possible grade for a test is 100, and each question is assigned a certain per cent value. For example, if ten questions are presented, ten per cent is allowed for a correctly written answer to one question. The teacher determines whether ten per cent shall be given on a question by the amount and correctness of the written answer. Another teacher may evaluate the same answer and assign a different grade.

The difficulty of each question is determined by the teacher at the time of making the test, and it is assumed that each question is worth ten per cent; whereas the same question given in a longer test will be worth less in proportion to the number of questions. If a teacher thinks that a certain question is more difficult than another, five per cent may be added to it. Obviously this five per cent must be taken away from

[1]For further reading concerning grading difficulties, see Ruch, G. M., *Improvement of the Written Examination*, Scott, Foresman, and Company, Chicago, 1924, Chapter III.

the assumed value of another question, because if all answers are correct the total cannot be more than 100 per cent. If, in the opinion of the teacher, a certain question is not fully answered, the grade is reduced to less than ten. So may all questions be graded, and when all answers have been thus subjectively evaluated and the per cents totalled, the score for the whole test is found. It may, for example, be 74 per cent, when 75 per cent is passing. Should chance conditions affecting the test have been altered, or if the examination paper had been corrected on a different day, perhaps the six per cent given on a certain question might have been seven or eight per cent, and the final grade would have been 76 or 77 per cent. Allowances for incomplete answers cannot be accurately determined, and there is really very little to show that one learner earned a grade of 80 per cent and another 85 per cent in such an examination.

265. Informal Objective Test. The unfairness and difficulties of the essay-type test suggest the need for a type of examination which will eliminate the undesirable features. Standardized and informal objective tests in shopwork should be used in greater numbers than at present. Should an abundance of standardized tests be available, the teacher's objective examinations would still be necessary in order to supplement them.

The objective test is so constructed that no discrepancies will exist between the grading of one teacher and the grading of another. The term *objective* is derived from this fact. The questions are prepared so that the learner is required only to make marks or to supply a word in order to answer a question, and

obviously, a very large sampling of the course of study up to the time of the test may be covered in one period. The preparation of questions is probably the greatest difficulty in the use of objective tests, but once the questions have been prepared the manner of giving the tests permits the use of the questions again for classes in the same subject. The scoring is convenient and requires no judgment. A key is usually made to be used in scoring, thus making possible rapid checking.

The teacher need not read any of the test papers. Many teachers permit the students to exchange papers and do the scoring by having the key read to them by the teacher. Since no judgment is required to weigh results, this can readily be done, and thus save time for the teacher. Informal objective tests are economical, as they can be mimeographed at small cost. Time usually spent in reading and interpreting written examinations may be given to other work when the objective test is used. It must be understood, however, that the informal objective test is not a standardized test, and is not satisfactory for comparing schools in different cities, because of the absence of norms. Comparisons based on the informal test can be made only within the class and between the classes for which the test was intended. It is devised to meet local conditions.

266. Standardized Objective Test. The standardized objective test differs from the informal objective test in that it is designed for wider use in comparing one school with another, as well as for standardizing subject-matter. Standardization still remains a problem for those who are interested in developing industrial

education. It may never be solved on a grade basis because of the great spread between the school grades in which the same shop subjects are offered. Whatever is done will be influenced to some degree by the analysis of instructional material and standardized tests.

The standardized test is devised somewhat according to the method briefly described in Chapter XIV. By applying objective tests to large numbers of individuals, data are obtained for norms. It is the table of norms that makes possible comparison of one school with another. Like the informal objective test, a given question can be answered in many ways, but only those who answer it in the correct way are given credit. The same question given to a class in Missouri will be credited in exactly the same way when given to a class in Colorado or Nebraska. Thus the entire test can be given in one city and scored elsewhere. By referring to the table of norms, one can compare the results obtained in one school with the results obtained in another.

For example, suppose that a table of norms shows that in a given test the twelve-year-old norm is 82. A learner who makes a score of 82 in Nebraska, Missouri, or elsewhere, is said to have the subject ability of a twelve-year-old, whether his age is less than or more than twelve. Grade norms are also furnished with some academic tests. This makes possible a comparison of grades as well as ages. However, they are not as satisfactory as age norms for comparison because the ages in a given grade vary.

Standard tests in all subjects show evidence of careful and scientific study. They are carefully prepared

and printed in leaflets or folders containing, on the front page, all the data necessary for the identification of the learner such as his name, age, grade, and school; clear directions for the individual who is taking the test; and a question or two answered in the proper form for illustration. Some tests even provide practice questions. The test itself contains special places for the answers. The questions are accompanied by a special pamphlet containing complete directions for the teacher in giving and scoring, as well as data concerning the validity and reliability of the test. And last, but not least, is the necessary table of norms.

While the standard test has many advantages, it also has a few disadvantages which may be regarded as of minor consequence. The cost of the tests, which must be purchased from publishers, are frequently out of range of many who would use them. There are also differences in the curriculum because of the local environment, which make the test rather unfair for some communities. In such cases, however, standard tests should be accompanied by informal objective tests. Another disadvantage, not of a serious nature, is that in order to determine results in experimental work the services of a technician, acquainted with statistical methods is necessary. However, for ordinary classroom purposes, most teachers can give and interpret tests if they give the matter a little study.

The standard test is a highly useful device for the improvement of teaching, even though it has a few disadvantages. The value gained thus far in the field of general education is so evident that those who are interested in further development of industrial educa-

tion should look to the development of achievement tests as one of the important next steps.

THE CONSTRUCTION OF TESTS

267. Determine What Is to Be Measured. The first consideration in constructing a test is to determine what is to be measured. Without instructional units this is a difficult task. In shopwork trade analysis offers an excellent solution. The trade or subject must be analyzed into the items, or units, that a learner must know and be able to do upon the completion of the course. Directions for analyzing subject-matter have appeared in recent years in magazines and in book form, and most shop teachers are familiar with their use. If the analysis of subject matter has been carried out successfully, a definite objective has been set up for the pupils, and the next incentive to learn is to have them know that they are to be held accountable through tests. The items for the test should be selected from the instruction units presented up to the time of the test, being careful to list them in sequence of occurrence in the course. This gives a better opportunity for the learner to follow a logical order of thinking. An order of difficulty need not be attempted in first construction, because the test-maker cannot readily determine an order of difficulty until the test has been tried. One reason for giving the test is to discover difficulties with a view of remedying them. Test items that are thought to be difficult often are answered correctly. The items selected should be comprehensive with respect to that portion of the course to be measured. Several simple questions, the answers to which

are surely known, should be presented at first so that a good start may be effected. There should be several questions so simple that the poorest of the class can answer them, and also several that are probably too difficult for the best in the class. This should give a test that includes the whole range of difficulties. The difficulties of the major portion of the test, however, are determined during the process of standardization.

268. Tests Must Be Evaluated. In preparing a test, consideration must be given to certain criteria by which the test may be evaluated. These criteria are: The test must be objective; it must be valid; it must be reliable; it must be comprehensive; and it should provide for economy of time in giving and scoring.

269. Test Should Be Objective. When an examination can be used by two or more examiners and give the same results it is said to be objective. The weighing of blocks of wood on scales during the process of determining moisture content is an objective process, because the scales used measure each piece alike for all members of the class, and the weights are not changed by subjective opinion or desire on the part of any member of the class. If a block is passed around to each member of the class and its weight determined by balancing it in the hand, it would be called a subjective process. Each person can express his opinion as to what the block weighs, and no two will be alike. And so in an examination, if it is to be objective, all chance for external influence must be eliminated. Then it is apparent that those who are examined will not be unfairly judged by chance opinion, or that scores will not be influenced by chance conditions affecting

the scorer. The new type test in order to be fair in measuring must be objective. The questions or statements must be in small units that eliminate writing, but require exact answers in single correct words.

270. Test Should Be Valid. When a test measures what it is supposed to measure it is said to be valid. This is determined by comparing it with some other known criterion that does measure the thing being tested. The validity of most mental tests is determined by statistical correlation with the Terman-Binet Test which is already known to be valid, and also school marks and general ratings of intelligence.

A criterion for validity in a shop test would be a comparison of actual ability in the shop subject being tested. Should several individuals who are known to be doing excellent work in the shops fail in a given test, there would be reason to believe that the test is not measuring what it is supposed to measure. Judgment of ability in the shop would need to be determined by competent persons.

Several factors contribute to the validity of a test. The questions should be representative of the main units of the course. Selection of questions that are seemingly more or less irrelevant cannot be true measures of knowledge or ability in the course. In order to overcome this difficulty in the informal test, the test items should be selected during the progress of the course, rather than at the time of the test. It is recommended by many that test items be prepared before the course begins. But often important points develop during the progress of the course that should be included in the test.

A good standard test usually contains information concerning the selection of the test items which gives the examiner a basis for judging the probable validity of the test. The opinion of competent individuals in the selection of test items is valuable in validating the test.

Other factors of importance in validation are objectivity, the method of scoring, and the reliability. Validity is not as difficult to attain, and is not subjected to as careful scrutiny, in the informal tests as in the standardized tests. Careful selection of test items which are comprehensive samples of the course is the important consideration in making informal tests and in insuring validity. Reliability is the most important factor, especially with respect to the standardized test.

271. Test Should Be Reliable. The reliability of the test refers to the accuracy with which a test measures the thing that it is supposed to measure. The reliability of a test may be stated as the accuracy of the test as shown by giving it at different intervals to the same pupils, or, by giving a duplicate form of the same test to the same pupils. If the test results are the same in both cases, it shows a high degree of reliability. All standardized tests should be accompanied by a coefficient of reliability showing the degree of correlation, or relation, between two forms of the same test, and thus also showing the accuracy with which each form of the test measures.

A number of conditions, many of which are obscure, influence the reliability of results. The physical condition of the pupils, the lack of validity, and objectivity

of the test, the length of the test, and the method of scoring the items, are a few of the factors which indirectly influence reliability. Tests of the new type are favored by those who use them because they have higher reliability than the old style essay-type. Reliability is one of the first considerations in selecting a test.

272. Test Should Be Comprehensive. Another important factor in the construction of tests is the extent to which the test items represent the whole course, or the portion of the course being measured. One feature of the new tests is that a larger and more comprehensive list of questions is possible. Care must be taken that all portions of the part of the course to be tested are adequately represented. The questions should cover the points of emphasis. The reason for this is that an individual who has made regular preparation and steady progress in a given course would be unjustly tested if the questions emphasized only a limited portion of the work to be tested. Tests with only a few questions, which is characteristic of the written test, obviously cannot be comprehensive.

273. Economy of Time in Giving and Scoring. The new type of test should, by its method of construction, provide for testing a larger number of items in a class period, and enable the examiner to score a larger number of tests with entire objectivity. The time required in the preparation of test items may be greater in the objective test, but the time used in testing and scoring is less than in the traditional type of test. A key should be carefully arranged so that items can be checked with a minimum of scanning.

The manner of scoring and the kinds of questions used determine scoring ease. The questions should be of such a nature that clerical assistance can be used. It is quite possible in most cases to exchange papers among members of the class and to have the class do the scoring. If the class does this work, serial numbers should be provided for all members of the class in order to hide identity and thus secure more positive scoring. A very desirable feature of new-type tests is the economy of time in using them, and every precaution should be taken to preserve this feature.

274. The True-False Question. There is a wide choice of questions which may be used in the new type of tests, but the true-false form is the one generally used. This form has its advantages and disadvantages. It is known as a recognition type in which there are but two answers, "true" or "false." The letters *"T"* and *"F,"* or the *minus* and *plus* signs, are most commonly used to designate the answers. When *"T"* and *"F"* are used, they are printed before the question, and the learner is required to encircle the one that designates the answer. When the plus or minus signs are used, the student writes the plus sign to designate "true," and the minus sign to designate "false."

EXAMPLE OF TEST USING THE "T" AND "F" MARKINGS

Some of the statements given below are true, and some are false. If, after reading the statement, you believe it to be true, mark a circle around the "T." If, however, you believe it to be false, mark a circle around the "F."

T. F. Professor C. M. Woodward was a leader in the Sloyd movement.

T. F. Instruction rather than production was the aim of the early Manual Training.
T. F. The early Manual Training schools were not vocational schools.
T. F. The Morrill Land Grant was made in 1850.
T. F. Industrial Arts was once thought to be basic to all trades.

EXAMPLE OF TEST USING THE "PLUS" and "MINUS" MARKINGS

Some of the statements given below are true, and some are false. If, after reading the statement, you believe it to be true place a "plus sign" in front of the statement. If, however, you believe it to be false, place a "minus sign" in front of the statement.

____ 1. All glue is water-proof.
____ 2. Cast iron is very good material for automobile gears.
____ 3. Bronze is a better material for bearings than cast iron.
____ 4. Ball bearings require lubrication.
____ 5. Kerosene is a good lubricant.

The true-false form of test is only one of several kinds that may be used alone or together. When selecting items for this test, a wide choice should be made in order to insure a good sampling of the material on which the learners are to be tested. The questions should be so stated that the truth or falsity will not be too obvious. They are best stated in the affirmative, and they must be clearly stated in order to avoid ambiguity. The questions should be independent of each other in order to avoid the possibility of association or elimination in answering. Short statements are more satisfactory than long ones because of the time element in reading, keeping in mind that they should be thought-provoking. A question should not exceed 18 to 20 words.

About half of the statements should be true and half false, and the order of arrangement should be by

chance in order to eliminate the possibility of the learner discovering an order. The number of items that should be used depends upon the amount of the material to be tested, and the length of the test. If true-false questions only are included, a very large number, upward of 100, should be used, especially if the utmost reliability is desired. Fewer may be used when they are combined with other types of questions. A test containing several types and a large number of questions would be even more reliable than a large number of one type.

It seems obvious upon examining a large group of true-false questions that one could guess and chance to answer a number of them correctly. In order to reduce the effect of guessing, the scoring should be done by subtracting wrong answers from right answers. Untried questions should not be counted. Should 54 correct items and 16 wrong items be accompanied by 10 untried items out of a possible total of 80, the score should be obtained as follows:

Possible number	80
Untried	—10
Right and wrong	70
Wrong	—16
Right	54
Subtract wrong from right	—16
Score	38

A key should be used in order to save time. Since it is probable that there will be more rights than wrongs, it saves time to mark the wrongs with a dash; to cross

out the untried ones; and to leave the right ones unmarked.

While the true-false form of test has the disadvantage of possible guessing, it is probable that this factor is not present to a great degree. The test can be constructed so that it requires reasoning and at the same time permits speed in answering as well as scoring. The advantages far outnumber the disadvantages.

275. The Multiple-Choice Question. This is a recognition form which gives the learner several choices. He is expected to underline, or otherwise mark, the word or words which give the correct meaning to the sentence. It is regarded as one of the best of the new types of questions. It is easy to score, and it can be made as comprehensive as the true-false question.

EXAMPLE OF TEST USING THE MULTIPLE-CHOICE QUESTION

Underline the word that will give the sentence the correct meaning:

Shellac is cut with (1) turpentine, (2) linseed oil, (3) alcohol, (4) lacquer thinner, (5) water.

A very satisfactory method of arranging a key to make scoring easy is to place in parentheses at the right the figure which indicates the correct word.

Another very satisfactory method which makes easy scoring, but requires more space, is to place all the words in a column at the right-hand side, and to place parentheses at the left in which the number of the correct word is to be written by the one taking the test.

EXAMPLE OF TEST, SECOND ARRANGEMENT

Place in the parentheses at the left the number of the word that will give the sentence the correct meaning:

(/) Shellac is cut with
1. turpentine
2. linseed oil
3. alcohol
4. lacquer-thinner
5. water.

Care should be taken in preparing multiple-choice questions to avoid words that would be recognized as incorrect by one who is unfamiliar with the work. An occasional absurdity is not out of place, but it should be very infrequent. It may serve at times to detect erratic or low-degree thinking. Infrequency rather than frequency of absurdities should be the rule. It must be remembered that a whole test may seem to be an absurdity to some learners, so that due allowances must be made for those that do appear without intention by the test-maker.

It is also desirable to use an occasional word that is nearly correct in order to provide opportunity for discrimination in shades of meaning. The number of words should be at least five, in order to reduce the chance for guessing. One of the advantages of this test is the elimination of the probable guessing, as in the true-false test, by the use of more than two choices. When fewer than five words are used the chance for guessing correctly is greater. The location of the correct word in the list should not be fixed, as that will give the crafty individual an advantage.

The scoring for the multiple-choice form should be the number of correct statements. This type of question is most reliable when 75 to 100 questions are used,

if it is used alone. It is very desirable, however, to reduce the number of questions and combine with other tests.

276. The Sentence-Completion Form of Question. This is a recall form and one of the most difficult. It is a statement from which an important word is omitted, with the omission indicated by a blank. Examples:

1. The Smith-Hughes bill was signed by President Wilson in .....

2. The ..... magazine, published at .....,
and the ..... magazine, published at .....,
are the principal magazines in the field of industrial education.

This test is not entirely objective, because a choice of words is often permissable, in which case opinion determines the answer. Opinion is also necessary in scoring, especially when analogous words are attempted. It is a good type of question, especially because it tests ability to form analogies. When preparing a completion test, special effort should be made to make statements in which only one word will suffice to complete the meaning. This tends to make the test more objective. In selecting the statements they should be made as comprehensive as possible with respect to the material to be covered. The completed statements should be made first and the important words stricken out, being careful not to strike out so many words that the meaning is not clear to one who knows the facts. The score is the number of spaces completed correctly.

Since this question requires some writing, fewer of them can be used in one test. Obviously it is not as comprehensive and reliable as tests which require less

time for answering each question, thus permitting the use of a greater number of questions.

277. The Single-Answer Question. This is a recall question which is more effective than the completion type because one word only can be used to answer, and thus it reduces the chance for opinion. It is derived from the traditional essay-type test, but the test-maker writes the question so that it requires only one word for an answer. A figure indicating the number of letters in the answer is often included in parentheses near the place where the answer is required. Example:

1. Oily rags should be placed in a receptacle specially provided for them, because such material is likely to cause what?
Answer ..... (4)

In this case the (4) indicates that the answer is a word of four letters.

2. What is a line around which a drawing is built called?
Answer ..... (6) ..... (4)

In this case the (6) and the (4) indicate that there are two words in the answer; one of six letters and one of four.

The practice of using a number in parentheses may on first thought appear to make the question easy. However, in practice it makes the question more specific, objective, and more readily scored. It is quite necessary for the learner to understand the subject being tested in order to answer the question even when the figure in parentheses is used. In order to discourage the practice of memorizing excerpts for tests, it is very desirable that the test questions should be made up without using sentences from the text. Scor-

ing is one point for each answer. Should certain questions necessarily require two answers, one point should be allowed for each answer.

278. The Matching Test. This is a recognition test which has been little used, but it is highly objective, and a large number of questions of a rather comprehensive nature may be used at one time. Two columns are used; certain facts, tools, materials, or other items, are placed in special order in one column and numbered; in the other column, in disarranged order, are certain events or things related to each word in the first column. The necessary number of the word in the first column must be placed in the parentheses in front of the item in the second column to which it is most closely associated. Example:

1. T-square	( )	Sharp black lines.
2. Compass	( )	Measuring angles.
3. 4-H Pencil	( )	Horizontal lines.
4. Ink-eraser	( )	Floor plans.
5. Engineer's scale	( )	Hexagon.
6. Architect's scale	( )	Vertical lines.
7. Triangle	( )	Tenths.
8. Protractor	( )	Never.

In order to reduce the chance of guessing, it is wise to have no fewer than ten items; and to avoid confusion no more than 20 items should be used. Should it be necessary to use more than 20 items, it is best to have more than one group. This test may be used in combination with other tests. It is scored by counting one point for each correctly matched item.

279. The Similarities Test. This is a recognition form seldom used because it has little value and other recognition forms are more readily prepared. It is

highly objective and easy to score. Four or more words are placed together, and the first word is related rather closely to one of the others. The word to which it is related is to be underlined. Examples:

1. Tap, tool, post, cold, nut.
2. Gear, iron, teeth, drill.

A seductive word is often used in compiling these test items. The chance of guessing is reduced by using more than three words. Scoring is one point for each correctly underlined word.

280. The Cross-Out Test. This is another recognition type that is seldom used. It is objective and easy to score. It gains its name because one word in a series is unassociated with the other words of the group, and must be recognized and crossed out. Scoring is one point for each correct cross-out. Examples:

1. Chuck, calipers, gears, lathe, solder.
2. Brace, hammer, saw, square, yardstick.

281. The Analogies Test. This also is a recognition type test and it is used more in mental tests than in achievement tests. Two pairs of analogous words are intended to be placed together, and one of the words is omitted and must be supplied. Examples:

1. Point : line :: line : ?
2. T-square : horizontal :: triangle: ?

Another method is to provide a choice of words in order to supply the correct one.

1. Point is to a line as line is to (edge, plane, pencil, ink).
2. T-square is to horizontal as triangle is to (octagon, celluloid, vertical, scale).

The latter method is more objective and easier to score, because the first method lends itself to choice of

words about which there may be need for decision in scoring. This type is also said to measure the higher discriminative abilities. It is a difficult test to prepare. Scoring is one point for every completed analogy.

282. The Performance Test. Performance tests are more often thought of in relation to intelligence tests. They are seldom used for testing achievement except in shop tests. They may be used to test knowledge as well as skill. In mechanical drawing, performance tests may be readily constructed to test skill in penciling, inking, or lettering, and knowledge of selection of views, dimensioning, and the like. In the shops, tool performance can be tested by constructing special tests involving the use of materials. Knowledge of tools, materials, and drawings can be tested by special printed performance tests. Skill and knowledge together may be similarly tested. The Nash-Van Duzee Test 1, Woodwork, Scale B, is an example of a standardized performance test. Informal performance tests can be made highly objective, reliable, valid, and comprehensive. While the scoring is done differently from that in printed tests, they are economical considering the comprehensive nature of such tests.

283. Decide Upon the Kinds of Test Questions. Being familiar with the criteria of a good test and what is to be tested, and having listed the exact items to be tested, the next step is to decide upon the kinds of test questions. It is well to use more than one kind in order to test a wider range of abilities. At least three or four tests in combination are recommended. The kinds of questions should vary from one test to another. Frequent tests should be given during the

progress of the work, and a final test should be given at the end of the course. The most used combination probably is one including true-false, completion, and multiple-choice statements. A few single-answer or matching questions are often added. However, the changing of questions from time to time provides opportunity for using all the kinds that have been discussed. The final test should include upward of 100 items and at least five kinds of questions. Throughout shop courses, which involve skills, performance tests should be given as well as knowledge tests.

The nature of the subject-matter to be tested often suggests the kinds of questions which are most suitable. When they have been selected, the test items should be reconstructed to fit them. Certain statements are more suitable to one kind of question than another. They should then be grouped so that all questions of one kind are together; that is, for example, so that all true-false questions are in one group. This makes scoring easy, and permits the learner to carry on associations suggested through the use of one group of questions at a time, and the directions necessary for answering each group of questions may be written in connection with that group.

284. Provide for Scoring. The questions should be arranged so as to provide for economical scoring. This should be done by having all answers appear on one edge of the paper. A key should then be made on a rather heavy strip of paper. The answers should be spaced so that the key can be laid directly on the test paper with each answer matching each question. It is desirable to use a colored pencil in checking items so

that danger of confusion with the pupils' markings will be reduced.

An economical method of scoring is to check the same group of questions in all papers before continuing to the next group. Such a scheme provides practice in scoring one kind of test and reduces the chance for error.

285. Directions for Taking the Test. A factor of major importance in constructing the informal objective test is the statement of directions for the learner. General directions should be given for the whole test as well as specific directions for each group within the test. The general directions are especially suggested for those who have not had experience with objective tests. The general directions should be briefly stated, and should contain the aim of the test with cautions about reading directions carefully and loitering on any single question. Example:

> The purpose of this test is to determine your knowledge of Part I of Mays' *"Problem of Industrial Education."* Specific directions are given with each group of questions. Read them carefully, and note how the sample preceding each group is answered. You probably will not be able to answer all questions. Do not stop too long on one question, but go on to the next. After the test is started do not ask questions.

The directions that accompany each group of questions should be carefully and briefly stated, and should contain an explanation of how the questions are to be answered, also a sample question correctly filled out. The following directions have been used with satisfaction, and are suggested for use before each special group of questions when groups of this character are used:

DIRECTIONS FOR THE TRUE-FALSE TEST

Some of the following statements are true, and some are false. Notice the "T" and "F" appearing before each statement. Draw a circle around the "T" if the statement is true. If the statement is false, draw a circle around the "F." Do not change the statements. Do not mark statements of which you are not sure. *Do not guess.* It reduces your score.

Example: T (F) Draft is a tool used by draftsmen

DIRECTIONS FOR THE MULTIPLE-CHOICE TEST

In each of the following statements five words or phrases appear and one of them is necessary to complete the meaning. Parentheses appear at the right of each statement. Underline the correct word or phrase, and also place its number in the parentheses. Your score will be the number of correct statements.

Example: 1. The term F. H. B. is used in describing (1) nails, (2) screws, (3) shipments, (4) abrasives.

DIRECTIONS FOR THE COMPLETION TEST

Each question below can be answered with a word in the blank space provided. Note that a number in parentheses is also provided to help you determine the correct word by giving the number of letters it contains. You may use a word that is longer or shorter if you are sure it is correct. Your score is the number of correct answers.

Example: 1. A *rip (3)* saw is used to cut wood with the grain.

DIRECTIONS FOR THE MATCHING TEST

Two columns of words or phrases appear below. The left-hand column contains certain facts, tools, materials, etc., which are numbered. The second column contains certain facts, one of which is related to one of the facts in the first column. They are in disarranged order in the second column, and you are to number them so they will be in proper relation to each word in the first column. Your score will be the number of correctly paired statements.

Example:

1. T-square	*2* Vertical lines
2. Triangle	*3* Sharp black lines
3. 4-H Pencil	*1* Horizontal lines

DIRECTIONS FOR THE SIMILARITIES TEST

Four words are placed together in each group of words below, and the first word is in some way related to another word in the group. Underline the other word. Your score will be the number of words correctly underlined.

Example:

1. Jig, top, *duplicate work*, pitch.

DIRECTIONS FOR THE CROSS-OUT TEST

In each group of words below, one word is out of place because in some way it is not related to the others. Find that word and cross it out. Your score is the number of words correctly crossed out.

Example:

1. Chuck, head, spindle, face-plate, ~~*triangle.*~~

DIRECTIONS FOR THE ANALOGIES TEST

The sample means: Point is to a line as line is to what? Underline the word in the parentheses that properly replaces the question-mark. Your score is the number of correct words underlined.

Example:

Point : line :: line : ? (edge, *plane,* pencil, ink).

286. It is Desirable to Make Two Forms of Each Test. Enough questions should be accumulated so that duplicate forms of the same test may be made. It is often necessary to change tests because two divisions of the same class meet at different periods, or to prevent coaching from one semester to another, and in cases of absence during examination.

When gathering questions, there should be twice as many as needed, and these can be divided at random and made into two forms. The questions may not be at all of the same difficulty, but the differences need not be of serious consequence. It is often possible to use the same questions by changing them from one kind of statement to another, and certain important topics

sometimes may be retained by variations in the questions concerning them. By following these suggestions on a large accumulation of questions, two forms may be constructed readily. New questions should be collected during the progress of the course and used as a reserve for making new tests.

287. Presenting Test Results. Test papers should not be given to the learners. They may be briefly examined following scoring, but should be promptly returned to the teacher. The value of using objective tests would be defeated by permitting lengthy scrutiny of them. New ones would be constantly needed.

Classes often are peculiarly different because of environmental influences that control the type of work presented. For this reason standardized tests cannot and should not be relied upon entirely, but should be supplemented by informal tests. Making norms for informal tests is unnecessary and should not be undertaken. Pupil comparisons can be made readily by using point scores. A simple method of doing this is to place the serial number of each learner in one column and the scores in an adjacent column. The scores should be placed in order from the lowest to the highest. This is a simple graphic method of comparing the pupil's scores.

Pupils' Serial Numbers	*Scores*
3	23
11	25
5	25
1	27
6	29
8	31
2	31
9	31
10	34
4	37
12	40
7	41

288. A Test for the Teacher. Tests are not ends in themselves. They are only a means of determining the success of the teacher and the achievement of the pupil, and any teacher who gives a test must understand that he is testing the efficiency of his own work as well as that of the pupils. If pupils have not learned what he expected them to learn he has failed to that extent, and should determine the cause.

289. Summary. Three forms of test are used: (1) the essay type, (2) the informal objective type, and (3) the standardized objective type tests. Certain criteria are necessary in order to evaluate tests and to aid in their construction. A test should be objective, valid, reliable, comprehensive, and it should provide for economy of time in giving and scoring. There are seven common forms of questions that may be used: true-false, multiple-choice, sentence-completion, single-answer, matching, similarities, and performance. Available achievement tests include standardized and unstandardized forms.

QUESTIONS—CHAPTER XIX

1. What is the purpose of testing?
2. What are the three major kinds of tests?
3. What are the criteria of a good test?
4. What is the value of the standardized test over the informal objective test?
5. How may the standardized test be limited in its use?
6. Describe each of the forms of the objective type questions.
7. What is the meaning of reliability? Validity? Objectivity?
8. Construct an informal objective test for a subject suggested by the instructor.

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APPENDIX

Examples of Available Achievement Tests

1. Introduction. Achievement tests in industrial work have not been available in commercial form until recently. At present there are several good tests. In order to enable the student to examine and make comparisons of tests and the kinds of questions used excerpts from several samples are presented. In each sample the directions and first part of the test are shown. No attempt is made to list all the tests, but those most widely known are described.

2. Nash-Van Duzee Tests in Woodwork. The Nash-Van Duzee Industrial Arts Tests in Woodwork[1] are designed to measure the student's attainments of the two major objectives of a course in woodworking. Scale A measures the acquisition of information, and Scale B the attainment of skill. An examination of data concerning these tests shows that intensive research and extensive trials have established for them a reliability comparable with the best tests in other fields of education. The authors do not propose these tests for the purpose of establishing standards, but merely to afford a means of measuring acquired knowledge and skill. The tests are standardized and afford a means of comparison of courses.

3. Reliability of the Tests. Since the tests exist in one form only, the Spearman-Brown formula for estimating statistically the reliability of a test was used. The author's description states that a reliability of .86 was found for the total test. The reliability for the various parts of the tests are: Part 1 (A) .61; Part 1 (B) .80; Part 1 (A and B) .85; Part 2 .80; Part 3 .94; Part 4 .88. These results compare favorably with the best academic tests.

The purpose of Scale A, as described, is to determine how much the student knows with respect to the processes, tools, materials, and other information required in woodworking. The complete test consists of: The Test, Manual of Directions, Key Sheet, and Class Record. There are four parts, containing 60 true-false statements, 42 incomplete statements, and 9 incomplete pictorial sketches of common joints, an incomplete drawing of a wood block which is really a completion test that involves performance, and 34 statements of the matching type divided into 6 groups. Excerpts from each part are shown.

[1]Bruce Publishing Company, Milwaukee, Wisconsin.

TEST I. WOODWORK

Scale A. Achievement

PART I

(A)—True and False Statements

Directions. Below, you will find a number of statements, some of which are true and some of which are false. In each case make a circle around the capital T if you think the statement is true, or make a circle around the capital F if you think the statement false. *Do not guess;* each incorrectly-marked statement counts as a penalty against you.

1. When stock is being squared up, the sliding T-bevel should be used in testing for squareness ..... T F
2. Basswood is a harder wood to work than oak ..... T F
3. Oily rags and waste always should be placed in wooden containers ..... T F
4. It is good practice to surface very short boards in a jointer T F

(B)—Incomplete Statements—Multiple-Choice-Response

Directions. Below are a number of incomplete statements. After each statement there are three words or phrases, each preceded by a number. You are to choose the right answer and write its number in the parentheses, as shown in the sample. Your score is based on the correct numbers entered in the parentheses. No penalty is exacted for statements incorrectly marked.

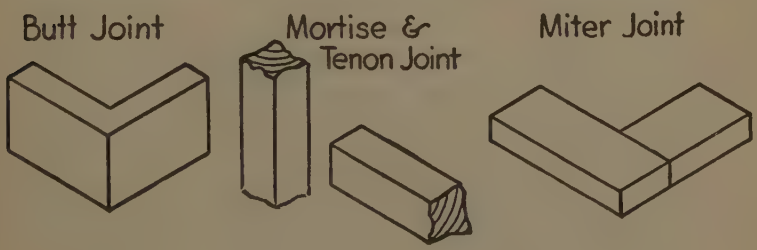
Sample. A plum is a
1 fruit 2 vegetable 3 metal ..... (1)

1. In laying out a joint in cabinet-making, it is best to use
1 knife 2 pencil 3 awl ..... ( )
2. "No. 5" stamped on the shank of an auger-bit indicates that the size of the bit is
1 5/16 in. 2 5/32 in. 3 5/8 in. ..... ( )

PART II

Wood Constructions

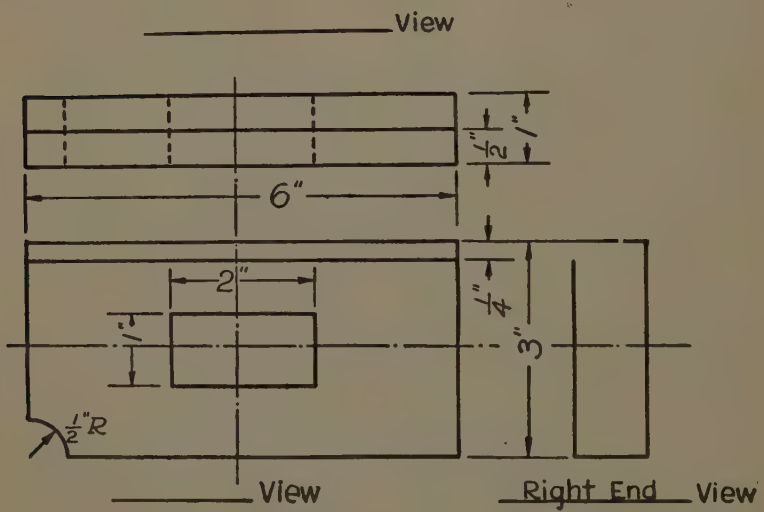
Directions. Below are a number of diagrams. There are three possibilities to think of in the case of each diagram. The diagram may be correct; a part may be missing; or a part may be put in incorrectly. In case it is correct, mark the figure *O. K.;* in case a part is missing, insert the missing part; and in case a part is incorrect, make the proper correction. Note that the diagram of the drawer has two joints and these should be treated as separate joints.



PART III

Reading a Drawing

Directions. You are to do three things with the drawing of the block shown below. First: Complete the right end view. Second: Fill in the names of the views not labeled. Third: In the incomplete statement following the drawing you will find a number of blanks. Refer to the drawing, and fill in the blanks with the necessary information.



PART IV

Tools and Processes

General Directions. Below are indicated certain tools and processes used in woodworking. The items listed in the left column, in each instance bear a number, and the blanks at the right of the paper are to be filled in with one of these numbers. Before each group of questions, you will find directions as to how the blanks are to be filled.

Group I

Determine the order in which the following processes should be performed in each job, and then list these processes in the blanks in that order, using the number appearing before each process. For example: The *first* process in "squaring up a board" is *"planing a surface true."* This process bears the number "5" in the left column; so "5" appears in the *first blank.* Now determine what process is performed next, and place the number of that process immediately under "5." Continue in this manner until all the blanks are filled.

Squaring Up a Board

Processes	Number of process in order performed
1. reducing to thickness	*5*
2. cutting to length	

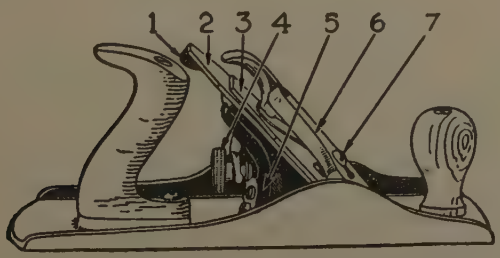
Rubbed Varnish Finish

1. varnishing	
2. staining	

Group II

Fill in the blank with the number which corresponds to that particular part in the drawing of the plane.

Name of part	Number of part
Frog	
Cap-iron	



Group III

Write, in the blank opposite the name of each process, the number representing the tool which is best suited to the performance of that process. For example: The tool needed for driving nails is a hammer; hammer is numbered 7; so 7 has been put in the first blank opposite "driving nails."

Tool	Processes	No. of Tool
1. Block-plane	Driving nails	7
2. Smooth-plane	Smoothing convex surfaces	

Filing a Saw

1. Oilstone	Jointing	
2. Three-cornered file	Side jointing	

Working Out a Convex Arc

1. Dividers	First removal of surplus	
2. Sandpaper	Paring to the line	

The following is a performance test involving the reading of a working-drawing, the selection of proper tools, and the ability to use them. It consists of The Test, Class Record, Scale for Scoring, and a Manual of Directions. The test itself consists of three parts: (1) The directions indicating what operations are to be performed, and the order in which they should be done; (2) a pictorial drawing showing how the block should look when completed; (3) a working-drawing which contains all dimensions and information needed.

TEST I—WOODWORK

Scale B—Performance

General Directions. This is a test designed to determine how well you can do the fundamental processes involved in woodworking. You will be given a block of wood upon which to perform these processes. All tools necessary will be provided for you. On the inside of this folder you will find a pictorial drawing which illustrates how the block will look when it is completed. You will also find a working-drawing (page 3), from which you will obtain dimensions and other necessary information. Read carefully all the directions and do the required work as skilfully and accurately as you can. Work as fast as you can, but always think first of the accuracy of your work. Be sure to do the steps in the order given. Ask no questions after you begin to work.

Working Directions. Do each of the following steps in the order indicated. Do nothing except what you are told to do. *In no case use sandpaper.*

1. Plane, square, and true a face; mark it No. 1 as shown in the pictorial drawing.
2. Plane, square, and true an edge; mark it No. 2 as shown in the pictorial drawing.

4. Nash-Van Duzee Tests in Drafting. The Nash-Van Duzee achievement tests in Mechanical Drawing are similar to the Woodwork Tests. All necessary data are provided for conducting them, including two forms of each test. Form 1, Part 1, contains direct answer, completion, multiple-choice, and recognition type questions. Form 1 and Form 2, Part 2, contain seven sections each of which involves performance.

5. Wells-Laubach Industrial Arts Tests. The Wells-Laubach Industrial Arts Achievement Tests[2] consist of knowledge tests in

[2]Published by the Manual Arts Press, Peoria, Illinois.

the fields of Mechanical Drawing, Woodwork, Printing, and Machine-Shop. The authors state that even though these subjects are offered below the ninth grade in many places, it seems advisable to consider the tests as tools for use in the ninth grade or above. A Manual of Directions which contains Directions and Key for Scoring, Class Record and a Set of Norms accompany each Test. The Mechanical Drawing Test contains 100 true-false statements, The Machine-Shop Test, of two parts, contains 100 true-false statements and 35 statements of the similarity type. The Printing Test and the Woodwork Test are each made in two parts, and each contains 100 true-false statements and 25 completion statements.

MECHANICAL DRAWING TEST, FORM A

Directions. The letters T and F precede each statement below. Encircle the letter T if the statement is true. Encircle the letter F if the statement is false. *Do not guess.* If you are unable to decide whether a statement is true or false, leave it alone. You will be penalized for each statement incorrectly marked by a deduction of one point or credit from the number of correctly marked statements. Notice the sample statement:

T (F) (Sample) : A drawing-board is usually made of hard wood.

Begin Here.

T F 1. The designer, inventor, or builder must be able to visualize or see clearly in his mind's eye what an object looks like without actually having the object.

T F 2. A good drawing should have clean cut lines and good lettering.

T F 3. An assembly drawing is a drawing which shows the relative position of the parts of the machine or structure.

MACHINE-SHOP TEST, FORM A

Part I

Directions. The letters T and F precede each statement below. Encircle the letter T if the statement is true. Encircle the letter F if the statement is false. *Do not guess.* If you are unable to decide whether a statement is true or false, leave it alone. You will be

penalized for each statement incorrectly marked by a deduction of one point or credit from the number of correctly marked statements. Notice the sample statement:

T (F) (Sample): A drawing-board is usually made of hard wood.

Begin Here.

T F 1. The center in the tail-stock of a lathe should be oiled.
T F 2. A lathe turning tool should have top and side clearance.
T F 3. A cut-off tool is used to cut off stock in the lathe.

Part II

Directions. Draw a line under the word or phrase that is most closely related to the first word.

Example: Bearing; soda water *scraper* tool

Begin Here.

1. Tool;	taper	spindle	cut-off
2. Lathe;	hammer	square	tail-stock

PRINTING TEST, FORM A

Part I

Directions. The letters T and F precede each statement below. Encircle the letter T if the statement is true. Encircle the letter F if the statement is false. *Do not guess.* If you are unable to decide whether a statement is true or false, leave it alone. You will be penalized for each statement incorrectly marked by a deduction of one point or credit from the number correctly marked. Notice the sample statement:

T (F) (sample) Type is always made of metal.

Begin Here.

T F 1. A lead is spacing material, usually 2 points in thickness, and may be of any pica length.
T F 2. An "em" is the square of any size of type.
T F 3. When a letter is placed in the stick correctly the side with the nick is up.

Part II

Directions. Fill in the blanks with the proper terms as used in printing.

1. A metal tray, or wooden tray, used to make up a form in is called a .....
2. A compositor uses a ..... to set type in.

WOODWORK TEST, FORM A

Part I

Directions. The letters T and F precede each statement below. Encircle the letter T if the statement is true. Encircle the letter F if the statement is false. *Do not guess.* If you are unable to decide whether a statement is true or false, leave it alone. You will be penalized for each statement incorrectly marked by a deduction of one point or credit from the number of correctly marked statements. Notice the sample statement:

(T) F (Sample): Mahogany is a costly wood.

Begin Here.

T F 1. It is easier to plane with the grain of the wood than against it.
T F 2. The jack-plane should never be filed.
T F 3. The block-plane is the smallest plane.

Part II

The following statements are incomplete, one word having been omitted where each blank is. You are to fill the blank with the proper word that will make the sentence a true statement.

Example: Common *nails* are made of wire.

Begin Here.

1. The ..... is the part of the plane on which the plane-bit rests.
2. A rip-saw and a .... saw resemble each other in appearance in all save the teeth.

6. Hunter Shop Tests. The Hunter Shop Tests[3] are designed to measure knowledge in Woodwork, Auto Mechanics, Carpentry, Mechanical Drawing, Machine-Shop, Electricity, Wood-Finishing, Pattern-Making, Printing, Shop English, and Shop Mathematics.

[3]Published by the Manual Arts Press, Peoria, Illinois.

There are 32 tests in which true-false, completion, multiple-choice, direct-answer, and matching statements are used. While there are too many tests to include samples of all, several are given to show how they are arranged.

E-2. OBJECTIVE TEST FOR ELECTRICITY

Directions. Fill in the blanks, or underline the right words, to make true meanings in the following sentences. Time—6 minutes.

1. Most auto storage-batteries are of the ..... volt type.
2. The potential of an ordinary dry-cell is approximately ..... volts.
3. Alternating currents may be stepped up or stepped down by means of a .....

W-14. MULTIPLE-CHOICE TEST FOR PATTERN-MAKERS

Directions. In each of the following sentences underline the word in parentheses which makes best meaning. Time—6 minutes.

1. A pattern-maker's tool used to cut semi-circular grooves is called a **(circular) (fore) (core-box)** plane.
2. The rounded inside corners of patterns made by filling with beeswax or leather are called **(fillets) (rabbets) (dadoes).**
3. Taper on the sides of a pattern to permit removal from a mold is called **(shrinkage) (draft) (rappage).**

AM-2. MULTIPLE-CHOICE TEST FOR AUTOMECHANICS

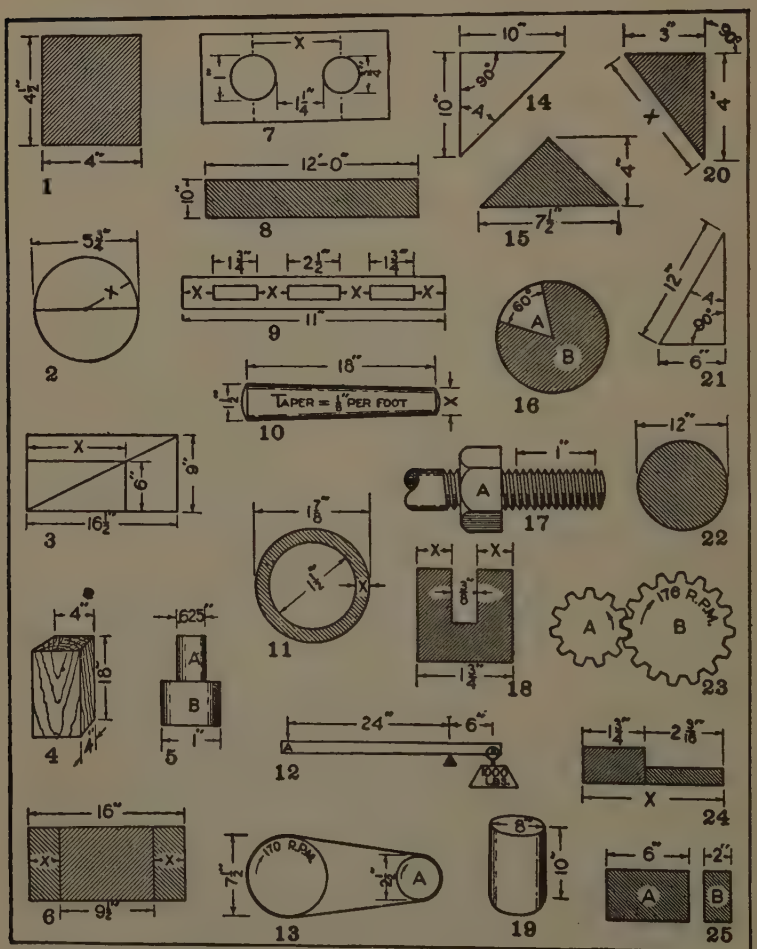
Directions. In each of the following sentences underline the word or words in parentheses that makes best meaning. Time—6 minutes.

1. The apparatus for providing air and gas in proper proportions is called a **(carburetor) (crank-case) (intake-valve).**
2. Differences in speed of the rear wheels are provided for by means of the **(clutch) (differential) (ring-gear).**
3. The distributor relays current to the **(storage-battery) (spark-plugs) (starting-motor).**

G-2. RELATED TEST IN SHOP MATHEMATICS

Directions. These questions refer to the numbered figures in the sheet of sketches on the following page. Fill in each of the blanks with the number which you believe is correct. Time—15 minutes.

1. The area of this figure is ..... square inches.
2. The radius X as indicated is ..... inches long.
3. The line as indicated by X is ..... inches long.



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AM-1. PARTS TEST FOR AUTOMECHANICS

Directions. Identify each of the parts represented in the sketches on the following page, by placing the names in the proper blanks. Time—5 minutes.

1 ..... 13 .....
2 ..... 14 .....
3 ..... 15 .....

7. Newkirk-Stoddard Home Mechanics Tests. The Newkirk-Stoddard Home Mechanics Tests[4] are the first standardized tests in this field. These tests are constructed, according to the authors, "for the purpose of measuring in an objective and diagnostic manner the essential knowledge that pupils should acquire from a well-organized course in Home Mechanics." There are two forms, A and B, with 36 units in each, making a total of 72 units. A Manual of Directions accompanying the test, contains information concerning validity, reliability, norms, scoring, administering, and interpreting test scores. A separate Key is furnished as well as Class Record Sheets. In addition to measuring and diagnosing achievement, the authors claim for these tests guidance, grouping, and research values.

8. Validity and Construction of the Test. Four criteria were used to establish the validity of the test:

(1) Surveys to check the jobs on the basis of social utility.

(2) Surveys of the actual teaching content of 75 representative schools.

(3) Analysis of courses of study and widely used commercial job-sheets which were based on surveys.

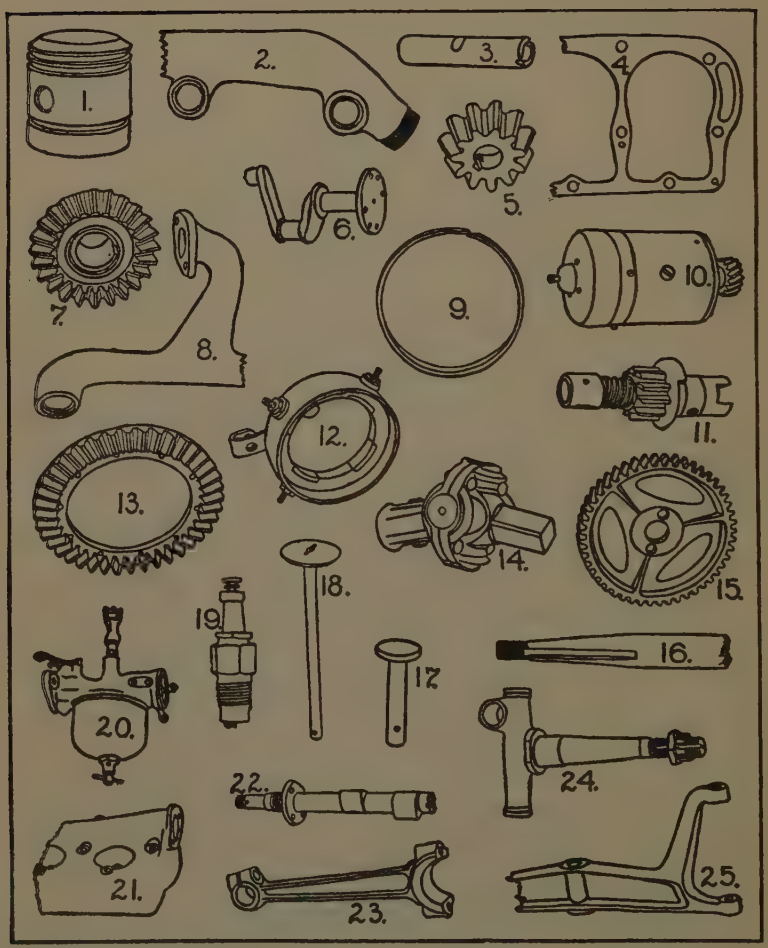
(4) Selection of jobs with procedures representative of a class of jobs rather than just a single job.

As a result of this study the following 72 high-ranking jobs in Home Mechanics were selected. These 72 jobs are not all the possible jobs in Home Mechanics, but they represent the major portion, and are the jobs which were found to be outstanding in their possibilities for usefulness in life situations.[5]

9. Reliability of the Test. The reliability of the test is a function of the agreement of the scores given to the same pupils by the two forms, A and B. This can be computed in the form of

[4]Published by The Bureau of Educational Research, State University of Iowa, Iowa City, Iowa.

[5]Newkirk-Stoddard Tests, Manual of Directions, p. 7.



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a coefficient of correlation (r). In the tables below are given various statistical measures which indicate the consistency of measurement by the test. It is not necessary for the teacher to understand these figures in order to administer the test, but they are helpful in the interpretation of results. A clear account of their significance can be found in Ruch-Stoddard: Tests and Measurements in High School Instruction (World Book Co., 1927), Chapter 20.[6]

Table 1

Reliability of a Single Form (A or B)
40 Minutes' Testing

Grade	No. in Sample	r		Standard Deviation		PE_{score}	
		Job	Point	Job	Point	Job	Point
7	50	.49	.86	2.5	26	1.2	6.6
8	50	.64	.89	3.0	29	1.2	6.5
9	50	.59	.85	3.2	24	1.4	6.3
7–9	150	.54	.86	2.9	27	1.3	6.8

Table 2

Reliability of Both Forms (A + B)
80 Minutes' Testing

Grade	No. in Sample	r		Standard Deviation		PE_{score}	
		Job	Point	Job	Point	Job	Point
7	50	.66	.92	4.5	50	1.6	9.5
8	50	.78	.94	5.5	56	1.5	9.3
9	50	.75	.92	5.7	45	1.9	8.6
7–9	150	.70	.93	5.4	53	2.0	9.4

NEWKIRK-STODDARD TESTS, FORM A

Part 1

Directions. On this and the following pages are given a number of common jobs in home mechanics. The proper steps for carrying out each job are given here, *but these steps are not placed in the correct order.* Examine each job in turn, and decide which step should come first. Place the number of this step in the first parentheses, that is, the parentheses at the left. In the same way insert the numbers of the remaining steps in the proper order of sequence,

[6]Ibid., p. 11.

so that when you have finished, one can read the numbers in the parentheses from left to right and find out just how to carry out the steps in the whole job.

Sample: Job: To set casters.
(1) Drive in caster sheafs.
(2) Select a bit and drill the hole.
(3) Select a suitable caster.
(4) Insert the caster and test.
(5) Mark the point for the location of the caster.

Rearrange the numbers to show correct procedure:

(*3*) (*5*) (*2*) ( ) ( )

The first thing to do is to "select a suitable caster." Since this is marked "3" in the above paragraph, a "3" is placed in the parentheses as shown. Marking the point for the caster is the next thing to do, so a "5" is placed in the answer. Then you should select a bit and drill the hole. Since this was marked "2" in the paragraph, a "2" comes next in the answer row. What step should come next? Find it in the paragraph, and copy its number in the next place in the answer row. In this job what is the last thing to be done? It is given in the paragraph. Find it, and copy its number in the last place in the answer row. You now have a row of 5 figures in parentheses which shows just how the numbered steps in the paragraph should be taken in order to do this job in the right way.

You are now ready to go on, but do not turn over the page or do any writing until the teacher gives the signal. *Don't waste time on a job you know nothing about; skip it, and go on to the next one.* You are allowed 40 minutes to complete the test.

Wait for signal.

No. 1. To Put New Fuller Ball in Faucet.
Procedure:
(1) Fasten new fuller ball in place.
(2) Unscrew front half of faucet.
(3) Shut off the water.
(4) Remove fuller ball.
(5) Assemble the faucet, turn on water and test.
(6) Determine where the faucet leaks.

Rearrange the numbers to show correct procedure:

( ) ( ) ( ) ( ) ( ) ( )

Part II

Directions. For the three jobs which follow the connections called for are to be indicated right on the diagrams by drawing in lines with pencil or pen. *Read the directions for each job very carefully.* When you have figured out how the wires should go, mark them in *neatly and clearly.* If you don't know all the connections, mark those you think are right.

Job. 2. To connect three dry-cells in series.

Directions. Show the correct circuit by drawing lines between the black dots.

10. Castle Mechanical Drawing Test. The Castle Test[7] is designed to measure knowledge and ability in Mechanical Drawing. It consists of 10 multiple-choice and 4 completion statements for testing geometrical terms, 8 diagrams for testing knowledge of dimensioning, and reading and interpreting features in a drawing, and two performance tests for testing ability in inking and penciling. A Manual of Directions is provided. It contains explanations of the test construction, directions for conducting and scoring the tests, and a lettering scale.

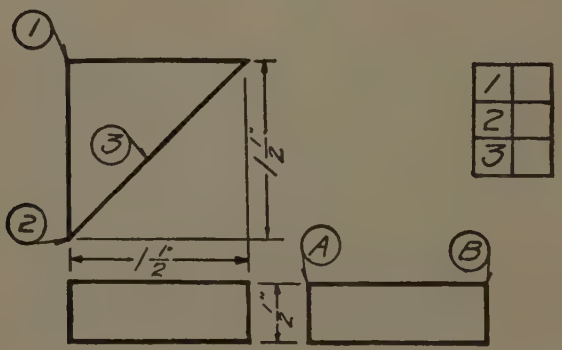
[7]Published by The Manual Arts Press, Peoria, Illinois.

CASTLE MECHANICAL DRAWING TEST

Instructions for Part No. 1 (a, b, and c)

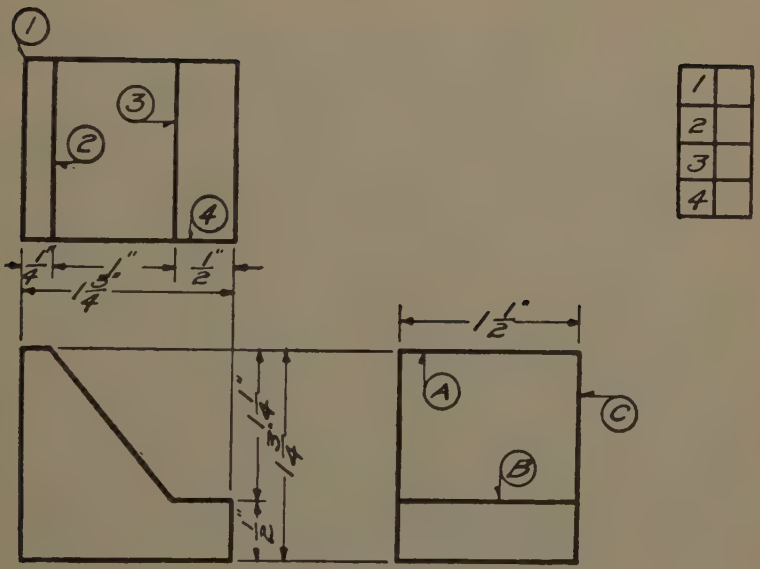
Notice the numbers in the circles on the top view. Notice that these numbers are repeated in the left-hand column of squares. In the circles on the side view are letters. After a careful study of the drawing it will be further noticed that certain numbers on the top view and certain letters on the side view point to the same part of the object. Place these letters opposite their corresponding numbers in the right-hand column of squares. The top view has one more circle than the side view. Consequently, one circle on the top view has no corresponding circle on the side view. The number in that circle is to have a blank space opposite it in the right-hand column of squares.

Sample



PART NO. 1a

Interpretation by Features



PART NO. 3

Geometrical Terms

Underline the word that applies.

(Sample)

Coins are:	Round, Square Long, Rectangular
1. Telephone wires are:	Angular, Vertical, Square, Parallel
2. To each other a telephone pole and wires are:	Obtuse, Vertical, Perpendicular, Opposite

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